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SENSORY INTERRELATIONSHIPS IN THE AUTOMATED TEACHING OF FOREIGN LANGUAGES.

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THREE EXPERIMENTS WERE CONDUCTED TO DETERMINE AND COMPARE THE EFFECTS OF VISUAL AND AURAL LANGUAGE LEARNING. SPANISH VOCABULARY ITEMS WERE LEARNED FIRST IN ONE SENSE MODE AND THEN RELEARNED IN A DIFFERENT SENSE MODE. TRANSFER EFFECTS WERE STUDIED FROM THE VOCABULARY ITEMS LEARNED TO PATTERNED (PICTURE-CUED) SENTENCES AND STORIES. TWO SAMPLES OF UNDERGRADUATE COLLEGE STUDENTS (80) WITH NO PRIOR SPANISH TRAINING LEARNED AND RELEARNED APPROXIMATELY 90 VOCABULARY ITEMS UNDER CONDITIONS WHICH CONTRASTED (1) PAIRED ASSOCIATE WITH RECOGNITION LEARNING, (2) PICTURES WITH ENGLISH WORD STIMULI, AND (3) SIMULTANEOUS VERSUS SEQUENTIAL PRESENTATION OF VISUAL MATERIALS. SUBJECTS WERE REQUIRED TO RESPOND IN WRITTEN OR SPOKEN SPANISH. SUBJECTS WHO LEARNED VISUALLY AND RELEARNED AURALLY DEMONSTRATED A MORE SUPERIOR PERFORMANCE UNDER ALL CONDITIONS TO THAT OF SUBJECTS WHO FIRST LEARNED AURALLY AND RELEARNED VISUALLY. THE VISUAL-AURAL SUBJECTS SHOWED SIGNIFICANTLY FEWER INITIAL LEARNING ERRORS, SIGNIFICANTLY LESS GUESSING IN RELEARNING, AND SIGNIFICANTLY GREATER TRANSFER TO SYNTACTIC COMPREHENSION. POSSIBLE EXPLANATIONS OF THE INTERSENSORY DIFFERENCES WERE DISCUSSED. (WN)

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Title VII Project Number 578
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Sensory Interrelationships in the Automated Teaching of Foreign Languages[1]

James J. Asher

San Jose State College

History of the Problem

One of the basic problems in creating a program for the automated teaching of foreign languages is: How is visual learning of an unfamiliar language related to the auditory learning of the language?

Generally speaking, the literature demonstrates that visual learning of a language is faster than auditory learning (Krawiec, 1946; Dunkel, 1948; Kessman, 1959). None of these studies were concerned with the learning of a language sample through one modality, then relearning through a different modality, except a study by Pimsleur and Bonkowski (1961). They found that with an artificial language in which the vocabulary was paralogs to English (i.e., "polef" means "green"), the sequence of learning aurally, then relearning the same vocabulary items visually was more efficient than the reverse. These results were interpreted as supports for the direct method of foreign language teaching which proposes that reading and writing should be delayed until speaking skill has been achieved.

Carroll in the Handbook of Research on Teaching criticizes the research on sensory learning because the learning tasks and procedures are unrelated to foreign language learning. Carroll points out that the experimental comparisons

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[1] The research reported herein was supported by a grant from the United States Office of Education, Department of Health, Education and Welfare.

of visual versus aural learning may not hold for foreign language learning because: (a) the procedure of paired associate learning is almost non-existent in most language teaching including the direct method; (b) the auditory subjects in these studies never have pretraining in the phonology and transcription of the spoken language whereas the visual subjects have had pretraining in the visual notation if the foreign language alphabet was similar to English; (c) the samples of language were too limited especially if one compares the usual experimental task of learning perhaps a dozen words with actual foreign language acquisition in which one learns many thousands of terms; (d) the aim in these experiments was not necessarily the active manipulation of the language; and (e) in the usual paired associate task, one element in each item is English, when in the direct method of language teaching, English may be used infrequently.

Some counterarguments to Carroll's objections are that the experiments are of course, reductionistic which means that because one is manipulating abstracted elements from the complex life setting, the results can not be projected directly back to the life situation. The value in the reductionism is that one has eliminated complicated events which are going on simultaneously with the one event we want to study. Professor Carroll's criticism is probably not concerned with the value of reductionism, but rather with the elements or relationships which have been isolated for study. One important element usually isolated for study has been learning. While the actual foreign language learning situation may not depend upon the paired associate technique of--

1. stimulus exposure,
2. time interval for the subject to respond, and then
3. stimulus and response exposure--

the underlying learning principles of the paired associate method are present in all techniques of language teaching including the direct method. These learning principles are contiguity, feedback, and reinforcement. If these were not present, learning would probably never occur. However, Professor Carroll is certainly correct that alternate criterion measures should be invented for the experimental study of language. Specifically these new techniques should offer measurement operations for: (a) pronunciation, (b) automaticity of language transmission, (c) permutation of elements as in the generation of grammatical units, (d) the transition from elements to patterns, (e) decoding, and (f) encoding.

The experiments reported in this paper were based on the traditional paired associate model, and were designed to explore the following problems:

1. What are the effects of learning a language through one sense modality, then relearning the same language through a different modality?
    a. What is the amount and direction of transfer when visual vocabulary learning precedes aural vocabulary learning?
    b. What is the amount and direction of transfer when aural vocabulary acquisition precedes the visual?
    c. What is the amount and direction of transfer from parts learning (vocabulary acquisition) to whole learning (syntactic comprehension)?
2. What kind of theoretical model can be constructed to explain the intersensory learning effects?

The strategy was an attempt to demonstrate that the intersensory findings would hold for a range of conditions including (a) recognition versus paired associate learning, (b) pictures versus English words as stimuli, and (c) simultaneous versus sequential presentation of visual materials. The general layout for the experiments was as follows:

Experiment	Learning Procedure	Items	
		Stimuli	Response
I	Recognition	English	Spanish_1 Spanish_2
II	Recall (Paired Associate)	Picture	Spanish
III	Recall (Paired Associate)	English	Spanish

EXPERIMENT I

The purpose of Experiment I was to explore intersensory relationships with recognition learning. Recognition learning means that the subject would be presented with an item such as this:

WORK

TRAMITAR TRABAJAR

The subject's task was to make a decision as to which of the two Spanish words meant "work." Notice the similarity between this technique of presentation and the Cook-Kendler (1956) technique of prompting.

Procedure

Half of the subjects were randomly selected as visual subjects and the other half were classified as aural subjects.

Sample list. Each subject learned a sample list of four items which were presented in this manner:

Trial 1, 2, 3. . . n.

	Stimulus	Exposure Time
1.	English	
	Spanish$_1$ Spanish$_2$	3 seconds
2.	Nothing (*S* wrote his response)	5 seconds
3.	Experimenter said "right" or "wrong"	

To control for serial learning effects such as position learning, on each trial the position of the Spanish words would randomly appear on either side of the English word, and on each trial the vocabulary items would appear in a different random order. When the criterion of learning, two successful responses in succession, was achieved for an item, the item was dropped from the list.

Visual predictor. Each subject learned the ten items in List 1 with the exact procedure of the samples. Stimuli were presented visually and S was required to write or print his response. This was a measure of each subject's visual ability to learn symbolic material.

Aural predictor. Each subject learned List 2 with the exact procedure of the samples except that stimuli were presented auditorily and S was required to pronounce his response. List 2 learning was preceded by a sample of four items in which S listened to the stimuli and pronounced his responses. Analogous to the operational meaning of List 1, List 2 was interpreted as a measure of the subject's aural ability to learn symbolic material.

Vocabulary learning. Subjects learned six more vocabulary lists (including Lists 3, 4, 5, 6, 7, and 8). The sequence of learning for each list was:

1. Learn the vocabulary list through sense modality X[2].
    - a. Translate two sentences[3] presented through sense mode X.
2. Relearn the vocabulary list through sense modality Y.
    - a. Translate two different sentences through sense mode Y.

---

[2] Sense modality X was vision for the visual subjects and audition for the aural subjects. Sense modality Y was audition for visual subjects and vision for aural subjects.

[3] The sentences were derived from the vocabulary list just learned. The sentence translations were taken as a measure of transfer from the elements, the vocabulary items, to patterned material.

Stories. At the climax of learning 92 vocabulary items[4], the subjects were asked to translate two stories derived from all of the vocabulary items. The first story was presented visually on a mimeographed sheet and the second story was presented auditorily with the Language Master. The translations of both stories were written. The stories were power tests in which the subject was permitted to read or listen to a story as often as he pleased in a 25 minute time limit.

Retention measures. After translating the stories, each subject was given a measure of recall and then a measure of recognition for each of the vocabulary items learned.

A schematic diagram of the design can be examined in Figure 1.

Subjects

The subjects (N=40) were undergraduate students who participated in the experiment to fulfill a course requirement. All subjects were screened to eliminate anyone with prior training in Spanish either in schools, at home, or by travel. The sex of the visual subjects was 5 females and 15 males; for the aural subjects, there were 4 females and 16 males.

Materials

The vocabulary items were equated by selecting English stimulus words from words labeled AA in the Thorndike-Lorge frequency count (1952). The English words were not only equated on the Thorndike-Lorge count but also on

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[4] Eight lists of ten items each, and three sample lists of four items each.

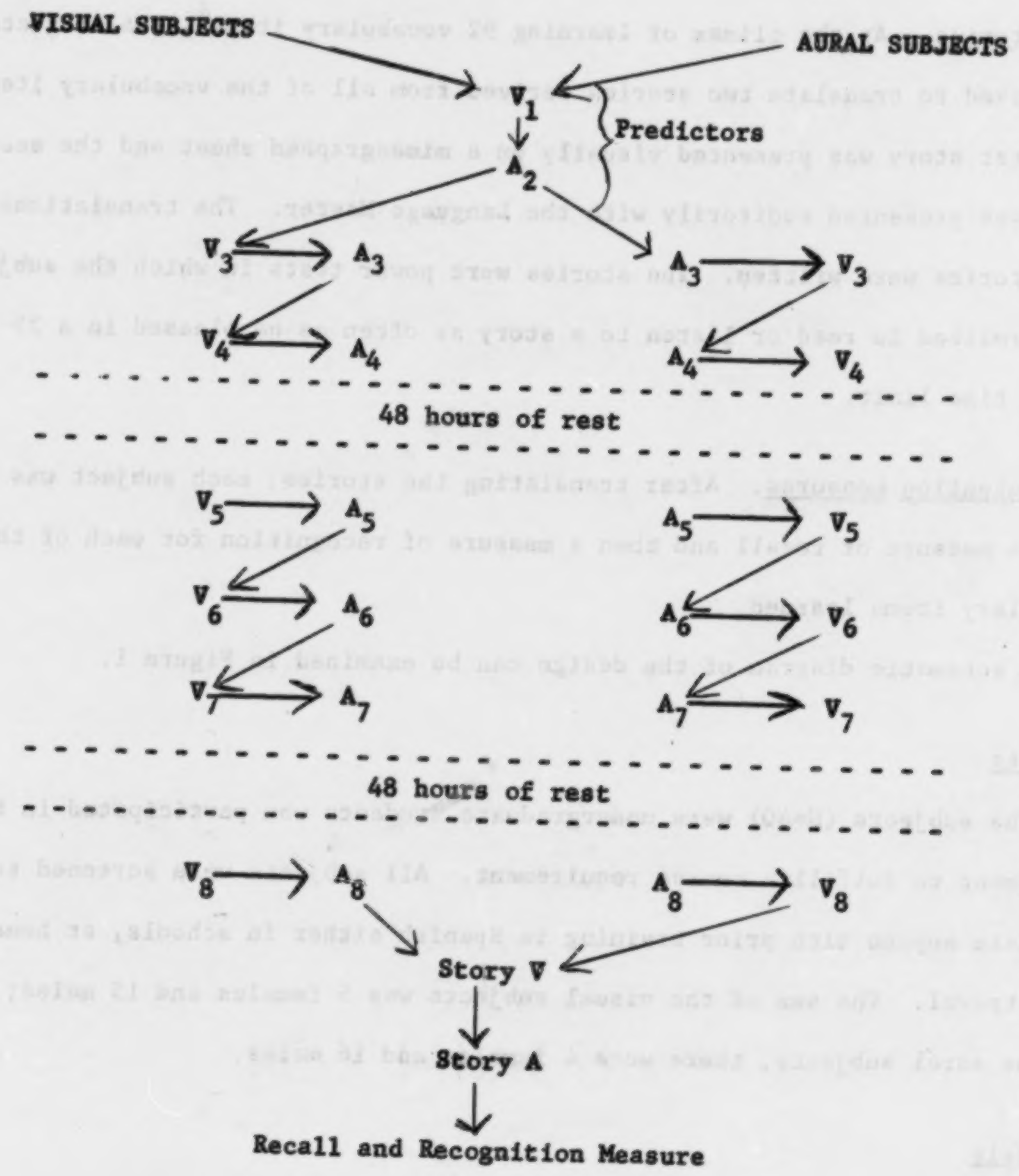

VISUAL SUBJECTS
AURAL SUBJECTS
V_1
A_2
Predictors
V_3
A_3
V_4
A_4
A_3
V_3
A_4
V_4
48 hours of rest
V_5
A_5
V_6
A_6
V_7
A_7
A_5
V_5
A_6
V_6
A_7
V_7
48 hours of rest
V_8
A_8
A_8
V_8
Story V
Story A
Recall and Recognition Measure

Figure 1. Schematic Diagram of the Experimental Design for Experiment I

a list of the most frequently spoken words as published in a monograph by Johnson (1944). Each vocabulary list contained the following parts of speech: one noun, two pronouns, three verbs, one adjective, one adverb, one preposition, and one conjunction.

Each vocabulary item was printed on a 5 x 8 card with a Wricoprint Lettering Set. The letters were 1/2 inch in size. The Guide No. was VC 1-2P and the pen code was Number 3. Each sentence was printed with Guide Number VC 3-8P, with pen code Number 3. The letters in the sentences were 3/8 of an inch high.

Apparatus

The vocabulary items and the sentences were visually presented with a Kardex. The Kardex is a commercially available type of office equipment which offered these unique advantages: (a) random access to any item which means that one may have rigorous prerandomization of items on all trials and yet at the same time have a precise record of the performance of each subject on any item for any given trial, and (b) the random access characteristic permitted items to be eliminated as they were learned. These advantages are not possible with some of the traditional methods of visual presentation such as memory drum, card shuffling, film, slides, or tachistoscope.

The auditory presentation of the vocabulary items and sentences was achieved with the Language Master. This machine played each vocabulary item and each sentence which the language consultant recorded on a strip of iron oxide across the bottom of a card. The Language Master permitted random access to the auditory materials, which is not possible with the tape recorder. This means, for example, that we were able to select immediately any vocabulary item from N items without the usual tape recorder problem of locating items by winding a tape forward or backward.

Results

Vocabulary learning. Language learning in the vocabulary acquisition was measured in errors. The total error (T) for each vocabulary list was divided into unique error (U) and perseverative error (P). The first time any vocabulary item was incorrect, this was counted as an unique error. Each mistake after the first error for a particular item was classified as a perseverative error. Perseverative error may be represented by: $P = T - U$. The following is a list of empirical generalizations for vocabulary learning, derived from Tables 1, 2, and 3.

All differences were in favor of the visual subjects.

1. Initial learning of vocabulary items - Lists 3, 4, 5, 6, 7

Type of Error	P Value[5]
Total	$<.05$
Unique	NSD
Perseveration	$<.01$

2. Relearning of vocabulary items - Lists 3, 4, 5, 6, 7

Type of Error	P
Total	$<.05$
Unique	$<.01$
Perseveration	NSD

---

[5] The significance levels for all t tests reported in this paper are one-tailed.

Table I

Vocabularly Learning: Experiment I

	Lists 3,4,5,6,7		List 8	
	Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Total Error in Initial Learning				
$\overline{X}$	26.75[a]	34.40	6.05	6.90
σ	9.70	14.12	2.40	3.30
t	2.00		.934	
p	$< .05$[b]		NSD	
Total Error in Relearning				
$\overline{X}$	8.00[c]	14.50	1.35	3.00
σ	9.86	12.22	2.08	1.95
t	1.85		2.59	
p	$< .05$		$< .01$	

---

[a] In Experiment I, the sample size was N=20 for visual subjects and N=20 for aural subjects.

[b] All significance levels in all tables were based on one-tailed tests.

[c] It is important to remember that in the vocabulary relearning, visual subjects were learning aurally and aural subjects were learning visually.

Table 2

Vocabulary Learning: Experiment I

	Lists 3,4,5,6,7		List 8	
	Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Unique Error in Initial Learning				
$\bar{X}$	19.00	20.45	4.45	4.20
σ	6.70	4.34	1.20	1.70
t	.819		.543	
P	NSD		NSD	
Unique Error in Relearning				
$\bar{X}$	5.65	10.60	.90	2.25
σ	5.92	6.29	1.00	1.30
t	2.56		3.65	
P	$<.01$		$<.0005$	

Table 3

Vocabulary Learning: Experiment I

	Lists 3,4,5,6,7		List 8	
	Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Perseverative Error in Initial Learning				
$\bar{X}$	7.70	14.15	1.60	2.70
σ	5.58	9.88	1.66	2.68
t	2.54		1.55	
P	$<.01$		$<.10$	
Perseverative Error in Relearning				
$\bar{X}$	2.35	3.90	.45	.70
σ	4.24	5.38	1.36	1.00
t	1.01		.663	
P	NSD		NSD	

3. Both visual and aural subjects showed positive transfer when they relearned vocabulary items through a different sensory modality. When the histograms in Figures 2 and 3 are compared for information on the amount of transfer, it can be seen that there is approximately 60% mean reduction in all categories of error for either visual or aural subjects.

4. In the results just reported, one important control problem was that although the time of exposure was the same for visual and aural materials, the pattern of presentation was different. For example, the visual materials were presented simultaneously while the auditory materials were presented sequentially. In an attempt to evaluate this factor, the visual presentation of List 8 was given sequentially[6]. The results again favored the visual subjects.

   a. Initial Vocabulary Learning - List 8

Type of Error	P Value
Total	NSD
Unique	NSD
Perseveration	$<.10$

---

[6] The visual words were stenciled in a horizontal line on a strip of cardboard which was then run on the guide track of a Language Master. The effect of the setup was that each word and the sentences in List 8 moved from right to left across S's view, as the subject peered through a 2 1/4 x 3 inch rectangle, cut in a large square of cardboard used to mask the Language Master.

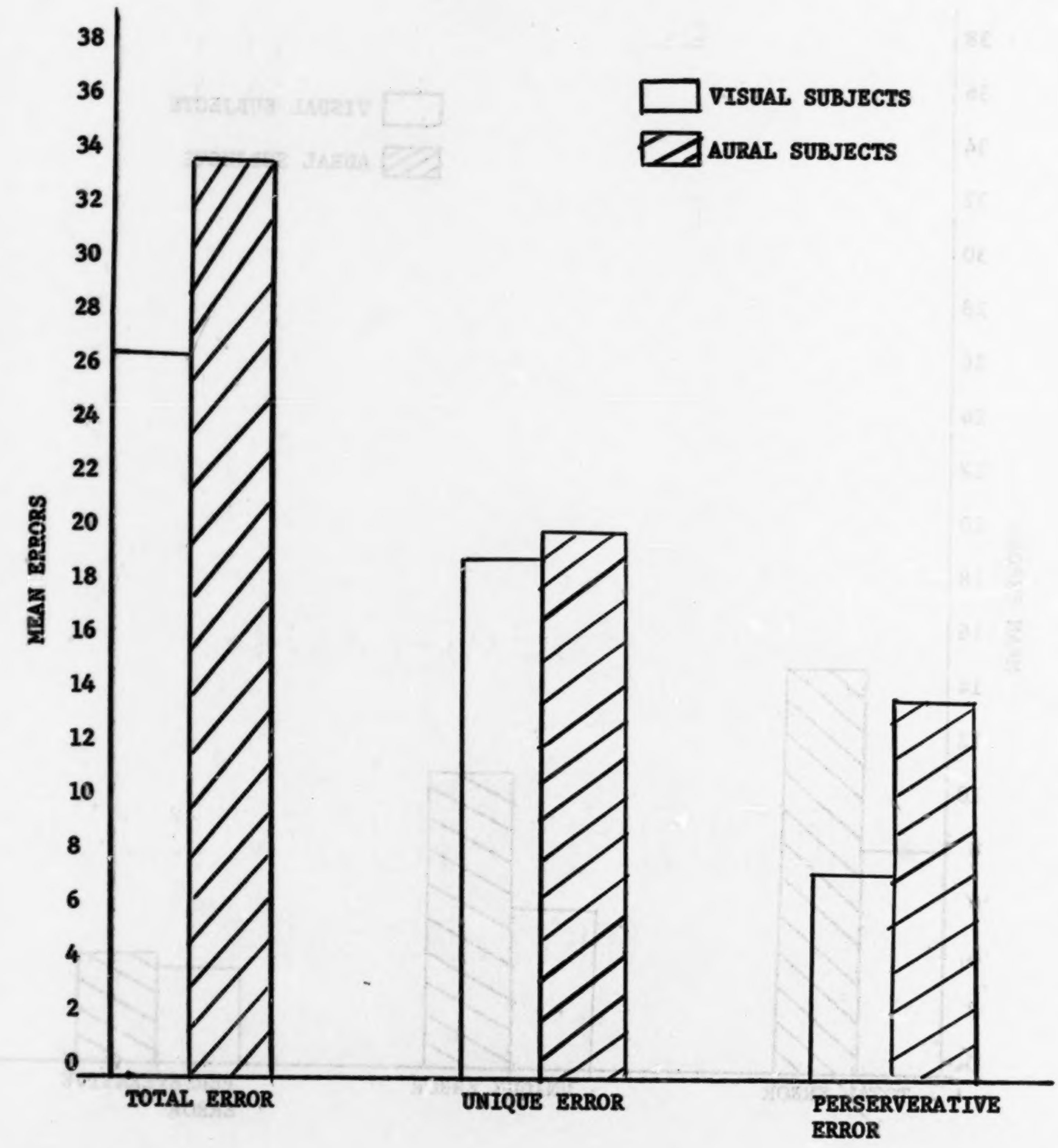
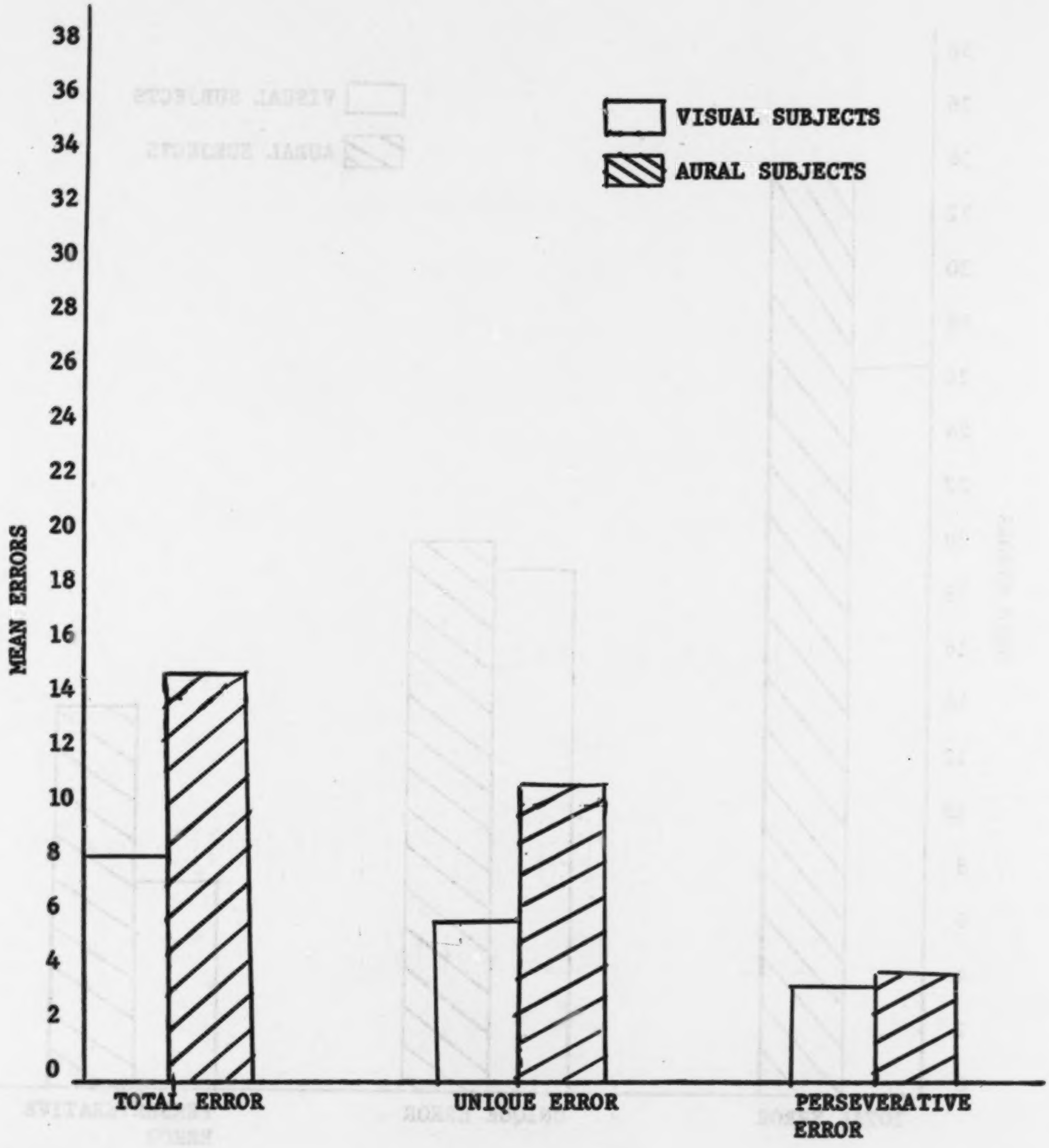


Figure 2. Initial learning of vocabulary lists 3,4,5,6,&7, when the visual presentation was simultaneous.



SIGNIFICANCE
LEVEL $p < .05$ $p < .01$ NSD

Figure 3. Relearning of vocabulary lists 3,4,5,6, & 7, when the visual presentation was simultaneous.

b. Relearning of Vocabulary - List 8

Type of Error	P Value
Total	$< .01$
Unique	$< .0005$
Perseveration	NSD

Notice that neither simultaneous nor sequential visual presentation seemed to change the intersensory findings for vocabulary which were that in initial learning, visual subjects made significantly fewer mean perseverative errors, and in relearning they made significantly fewer mean unique errors.

Sentence translations. After vocabulary items were initially learned, the immediate transfer to the sentences showed that visual subjects:

1. Identified significantly more correct words within the sentences at $P < .0005$, and
2. Correctly discerned more of the sentence meanings with $P < .005$.

A detailed presentation of the statistics can be examined in Table 4 and Figure 4. The reliability coefficients for the judgment of sentence meaning by two independent raters were all .90 or higher.

After vocabulary relearning, the immediate transfer to the sentences showed that visual subjects:

1. Were not significantly different in identifying correct words within the sentences, but
2. Correctly interpreted significantly more sentence meanings with a $P < .10$.

The transfer to sentence findings held whether the technique of visual presentation was simultaneous or sequential.

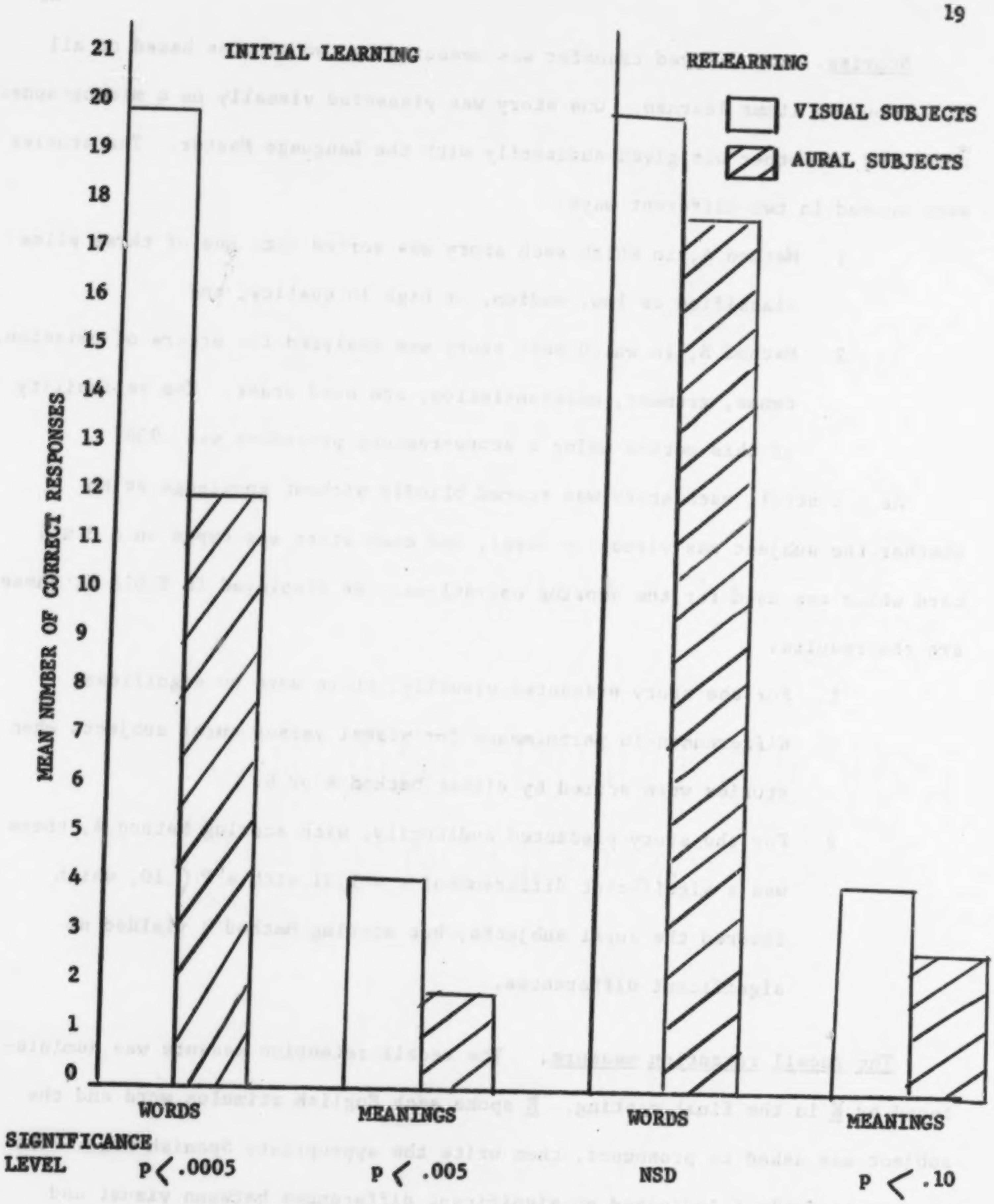
Table 4

Sentence Translations: Exp. I

	Visual Subjects		Aural Subjects
Number of Words Identified Within the Sentences After Initial Learning[a]			
$\bar{X}$	19.70		12.20
σ	5.60		4.94
t		4.75	
P		$<.0005$	
Number of Words Identified Within the Sentences After Relearning			
$\bar{X}$	19.65		18.00
σ	6.85		5.56
t		.838	
P		NSD	
Number of Sentence Meanings[b] **Which Were Understood After Initial Learning**			
$\bar{X}$	4.05		1.75
σ	2.96		1.67
t		3.03	
P		$<.005$	
Number of Sentence Meanings Which Were Understood After Relearning			
$\bar{X}$	4.05		2.75
σ	3.26		1.97
t		1.53	
P		$<.10$	

[a] The total number of words within the sentences was 72.

[b] The total number of sentence meanings was 12.



Figue 4. Syntactic transfer measured in words within sentences identified, and meanings of sentences which were understood.

Stories. The delayed transfer was measured by two stories based on all 92 vocabulary items learned. One story was presented visually on a mimeographed sheet and the other was given auditorily with the Language Master. The stories were scored in two different ways.

1. Method A, in which each story was sorted into one of three piles classified as low, medium, or high in quality; and
2. Method B, in which each story was analyzed for errors of omission, tense, grammar, mistranslation, and word order. The reliability of this method using a score-rescore procedure was .938.

As a control, each story was scored blindly without knowledge as to whether the subject was visual or aural, and each story was typed on a 3 x 5 card which was used for the scoring operations. As displayed in Table 5, these are the results:

1. For the story presented visually, there were no significant differences in performance for visual versus aural subjects when stories were scored by either Method A or B.
2. For the story presented auditorily, with scoring Method A, there was a significant difference of $t = 1.31$ with a $P < .10$, which favored the aural subjects, but scoring Method B yielded no significant differences.

The recall retention measure. The recall retention measure was administered by *E* in the final meeting. *E* spoke each English stimulus word and the subject was asked to pronounce, then write the appropriate Spanish word. The t tests in Table 6 indicated no significant differences between visual and aural subjects in vocabulary items recalled. However, the trend in all cases favored the visual subjects.

Table 5

Stories: Experiment I

	Scoring Method A		Scoring Method B	
	Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Visually Presented Story				
$\bar{X}$	1.75	1.65	39.65	40.30
σ	.89	.65	16.30	13.42
t	.40		.138	
P	NSD		NSD	
Aurally Presented Story				
$\bar{X}$	1.35	1.60	51.85	47.55
σ	.66	.74	17.20	15.16
t	1.31		.838	
P	$<.10$		NSD	

Table 6

Retention Measures: Experiment I

	Lists 3,5,7[a]		Lists 4,6,8[b]	
	Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Recall of Vocabulary Items				
$\bar{X}$	12.15	10.10	6.70	6.65
σ	4.60	4.82	5.62	4.89
t	1.38		.03	
P	$<.10$		NSD	
Recognition of Vocabulary Items				
$\bar{X}$	28.15	24.60	26.00	24.90
σ	2.08	2.64	3.58	2.78
t	4.70		1.08	
P	$<.0005$		NSD	

[a] These items were presented visually in the recognition test.

[b] These items were presented aurally in the recognition test.

The recognition retention measure. The recognition retention measure was taken for each item after the recall test. For example, E pronounced the English stimulus word, then S pronounced the Spanish, wrote the Spanish, and then tried to identify the correct Spanish term from two possibilities presented to him. The decision between two Spanish words was the recognition measure. The finding here was:

1. For the half of the vocabulary items which were presented visually for recognition, the visual subjects recognized significantly more with a t of 4.70, which for df = 38 has a P $<$ .0005; and
2. For the half of the vocabulary items presented for auditory recognition, there were no significant differences between visual and aural subjects.

The predictor measures were vocabulary Lists 1 and 2. List 1 was presented visually with written responses required of the subjects, and List 2 was transmitted auditorily with spoken responses required of subjects. The predictor measures were used for these purposes: (a) to determine baselines or the homogeneity of language learning ability for visual and aural subjects; (b) to determine the validity of work sample measures in predicting performance in language learning; and (c) to determine sensory dominance in the subjects.

Homogeneity of subjects. Although the subjects were randomly classified as either a visual or aural subject, language ability was measured with the predictors. These findings showed homogeneity of language ability with:

1. The visual learning predictor, vocabulary List 1, indicating no significant differences between visual versus aural subjects for all categories of error: total, unique, and perseveration; and,

2. The aural predictor, vocabulary List 2, exhibiting no significant differences between visual versus aural subjects for all categories of error: total, unique, and perseveration.

Validity of the predictors. Validity coefficients for the visual predictor are displayed in Table 7. The low coefficients seemed to be the result of a restricted range in the predictor measure. The validity coefficients for the aural predictor in Table 7 are higher, but still the restricted range seemed to be a limiting factor.

One strategy for expanding the range in the predictor measures would be to combine the visual and aural predictors. This was done for each category of error resulting in three composite predictor scores for total, unique, and perseverative error. As can be seen in Table 8, the composite predictor score correlated highly with the criterion measures.

The reliability of the criterion measures was computed by correlating performance on the odd lists (3, 5, 7) versus the even lists (4, 6, 8). These reliability coefficients, corrected by the Spearman-Brown formula for split-halves, are displayed in Table 9.

Sensory dominance. Perhaps the intersensory findings can be explained as a function of sensory dominance. The concept of sensory dominance is analogous to hand and eye dominance. If this factor exists, then subjects who are visually dominant should have more accelerated learning if they happened to be in the group who learned the material initially by vision in comparison to visually dominant subjects assigned to learn the language initially by listening and speaking. Conversely, if one were aurally dominant, his performance should be better if he happened to be assigned as an aural

Table 7

Validity Coefficients for The Single Predictors: Experiment I

Criterion Measure (Lists 3,4,5,6,7,8)	Visual Predictor (List 1) T	Visual Predictor (List 1) U	Visual Predictor (List 1) P	Aural Predictor (List 2) T	Aural Predictor (List 2) U	Aural Predictor (List 2) P
Visual Subjects (N=20)						
T[a]	.279	.419*	.075			
U	.259	.449*	.001			
P	.278	.345	.144			
Aural Subjects (N=20)						
T				.470*	.297	.467*
U				.390*	.377	.267
P				.479*	.235	.516**

Note: * significant beyond .05
** significant beyond .01
*** significant beyond .005

[a] T = Total errors
U = Unique error
P = Perseverative error

Table 8

Validity Coefficients for the Composite Predictors: Experiment I

Criterion Measures	Composite Predictors (List 1 + List 2)			
	Visual Subjects		Aural Subjects	
	T	U	T	U
Vocabulary Learning (lists 3,4,5,6,7,8)				
T[a]	.300	.523**	.834***	.616***
U	.281	.520**	.801***	.696***
P	.296	.480**	.792***	.531**
Sentences[b]				
#words correct	-.540**	-.620***	-.708***	-.613***
#meanings	-.586***	-.658***	-.536**	-.474*
Recall (lists 3,5,7)	-.160	-.435*	-.707***	-.606***
Recognition (lists 3,5,7)	-.116	-.219	.747***	660***

Note * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] T = Total error
U = Unique error
P = Perseverative error

[b] The sentence score was based on sentences presented after initial learning.

Table 9

Reliability Coefficients[a] for the Vocabulary Learning Experiment I

Odd Lists (3,5,7) vs. Even Lists (4,6,8)	Visual Subjects	Aural Subjects
T[b]	.787	.918
U	.789	.921
P	.629	.789

[a]All coefficients are significant beyond the .005 level.

[b]T = Total Error
U = Unique Error
P = Perseverative Error

Note: All correlations were adjusted by the Spearman-Brown formula for split halves.

rather than a visual subject.

Since sense dominance was not a main variable in this study, the experiment was not designed to include it. However, our data do offer some evidence concerning this factor.

Sensory dominance was measured from the predictor measures. Specifically, sensory dominance was operationally defined as a difference score (D) between the visual and aural predictors. For example, if a subject had more errors on the visual predictor (V) than the aural predictor (A), then that subject was classified as aurally dominant. If V was less than A, then the subject was classified as visually dominant. The scoring is illustrated here:

	Visually Dominant	Aurally Dominant
Errors on the visual predictor	10	20
Errors on the aural predictor	20	10
D score	10	10

Since there were three categories of error: total, unique, and perseveration, subjects were classified on sense dominance three times.

Notice that although one may be classified as visually or aurally dominant, the amount of dominance will vary from subject to subject. Every subject within the visual dominance classification, as an illustration, will not have exactly the same amount of visual dominance as measured by the D scores. Therefore, it would be misleading to compare visually versus aurally dominant subjects unless the amount or intensity of dominance was constant for both groups.

Only D scores based on unique error, sorted subjects into visual versus aural dominance classifications in which the mean intensity of dominance for the visual dominants was approximately the same as the intensity of dominance for the aural dominants.

Intensity of Dominance When D Scores
are Based on Unique Error

D Score	Subjects Who Learned Initially by Vision		Subjects Who Learned Initially by Audition	
	Visually Dominant N = 11	Aurally Dominant N = 8	Visually Dominant N = 7	Aurally Dominant N = 7
$\bar{X}$	2.27	2.12	2.42	1.85
σ	1.05	1.11	1.29	.99

With amount of dominance held constant, the data supported the sense dominance hypothesis. That is, of those who initially learned material visually, subjects who were visually dominant had fewer mean errors than those who were aurally dominant. Conversely, of those who initially learned material aurally, subjects who were aurally dominant had fewer mean errors in vocabulary acquisiton than those who were visually dominant. Although the statistical results in Table 10 show three of the four mean comparisons significant at P = .10, these findings should be interpreted with caution since the number of subjects in each classification was so small. A new study should be designed exclusively to explore the sense dominance factor. Since most of our college subjects tended to be visually dominant, any new study probably should draw samples from a non-college population such as high school or grade school students.

The guessing measure. No training trials were given the subjects. On the first exposure to the vocabulary items, subjects were asked to make a selection

Table 10

Vocabulary Learning for Subjects

With Different Sensory Dominance: Experiment I

	Visual Subjects		Aural Subjects	
	Visual Sensory Dominance	Aural Sensory Dominance	Visual Sensory Dominance	Aural Sensory Dominance
Unique error in the initial learning of vocabulary (Lists 3,4,5,6,7)				
N	11	8	7	7
$\bar{X}$	17.27	20.12	21.85	17.71
σ	5.10	3.89	6.03	3.73
t	1.38		1.54	
P	$<.10$		$<.10$	
Unique error in the re-learning of vocabulary (Lists 3,4,5,6,7)				
N	11	8	7	7
$\bar{X}$	5.27	10.75	6.00	7.14
σ	7.10	7.50	4.21	6.77
t	1.61		.379	
P	$<.10$		NSD	

by guessing if they did not know which of the two Spanish words was correct. The first trial on all vocabulary items was defined as the guessing score, which was recorded in errors.

Curiously, we found that the guessing score was highly correlated with all measures of language learning including: (a) vocabulary acquisition; (b) syntactic comprehension; (c) the recall retention measure; and (d) the recognition retention measure. Most of the correlation coefficients between guessing and language learning, displayed in Table 11, were between .50 and .80, all significant well beyond the .01 level.

Since the guessing score was contained within the unique error score of the predictor measure, it would be interesting to see how much the validity of the predictor would be reduced when the guessing measure was held constant by partial correlation. The unique score for the composite visual and aural predictors was used rather than either single visual or aural predictor because the composite score gave higher validity coefficients, probably as a function of the expanded range.

The results of the partial correlations in Table 12 indicate that a substantial amount of the variance in the composite predictor measure can be accounted for with the guessing score.

Experiments II and III were designed to further explore this phenomenon of guessing.

Table 11

Correlations Between the Guessing Score and Each of the Performance Measures Experiment I

	Visual Subjects N=20	Aural Subjects N=20
Initial Vocabulary Learning		
T^a	.820***	.782***
U	.835***	.920***
P	.725***	.661***
Relearning of Vocabulary		
T	.543**	.683***
U	.528**	.694***
P	.523**	.600***
Sentences after Initial Learning		
#words correct	-.510*	-.466*
#meanings	-.385*	-.424*
Sentences after Relearning		
#words correct	-.626***	-.364
#meanings	-.696***	-.240
Stories		
Visual	.699***	.533**
Aural	.665***	.472**
Recall (Lists 3,5,7)	-.698***	-.544**
Recognition (Lists 3,5,7)	-.612***	-.562***
Composite Predictors		
T-	.301	.815***
U	.451**	.720***
P	.050	.044

Note: * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

^{a}T = Total error
U = Unique error
P = Perseverative error

Table 12

Partial Correlations Between the Unique Error Score of the Composite Predictor and Performance Measures, When the Guessing Score is Held Constant

	Visual Subjects N=20	Aural Subjects N=20
Initial Vocabulary Learning		
T^a	.299	.012
U	.293	.012
P	.357	.016
Sentences, after Initial Learning		
# Words correct	-.508*	-.450*
# Meanings	-.587***	-.269
Recall	-.262	-.368
Recognition	-.081	-.444*

Note * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] T = Total Error
U = Unique Error
P = Perseverative Error

EXPERIMENT II

The purpose of Experiment II was to determine if the intersensory findings of Experiment I would hold when (a) the stimuli were pictures instead of English words, and (b) the technique of presentation was paired associate which requires recall instead of recognition. The use of pictures was an attempt to eliminate English as the mediating process. Learning was structured to be direct from the foreign language to the meaning.

Procedure

Sample list. The procedure was basically the same as Experiment I, with these variations:

Training:

Trial 1

Stimulus	Exposure Time
1. Picture (i.e., boat)	1 second
2. Spanish word (i.e., barco)	1 second

Test:

Trial 1 + k
(Where k = 1, 2, 3, . . .n)

Stimulus	Exposure Time
1. Picture	1 second
2. Nothing (S wrote or pronounced his response)	5 seconds
3. Spanish word	1 second

Items, presented randomly on each trial, were eliminated from the list as the subject responded correctly twice in a row.

Picture vocabulary - List 9. Visual subjects learned vocabulary List 9 visually, then relearned the same items auditorily. The aural subjects reversed the sequence by learning aurally and relearning visually.

Picture vocabulary - List 10. Here visual subjects learned vocabulary List 10 auditorily, then relearned the same items visually. The aural subjects reversed the sequence by learning visually and relearning aurally.

Predictor measures. All subjects learned the visual and aural predictor measures, Lists 1 and 2, which were used in Experiment I. The only difference was that the administration was paired associate as described in the section under Sample List.

If the predictor measures, which had English words as stimuli, had preceded the picture vocabulary learning, there is the possibility that subjects may have learned that one should use English to mediate between the concept and the foreign symbol. Since the aim in the picture vocabulary learning was to eliminate dependency on English as a mediator between a concept and the foreign language, the risk of mediation was reduced by giving the predictors after the picture vocabulary learning.

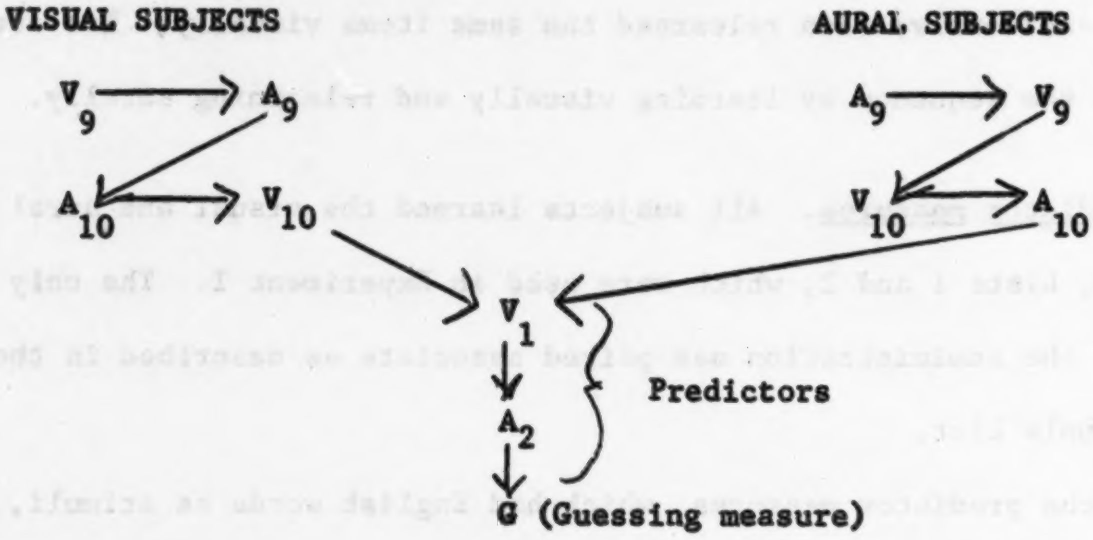
Guessing measure. Vocabulary items from Experiment I were visually presented to the subjects. Here is an illustration of a typical item:

WORK

TRABAJAR TRAMITAR

S's task was to guess which of the Spanish words was the correct selection. E gave no feedback as to the correctness of the response. This guessing measure was based on items from List 3, 4, 5, 6, 7, and 8.

Here is a schematic diagram of the design for Experiment II.



Subjects

The subjects (N = 40) were recruited from classes required of all freshmen students at San Jose State and the participants were paid for their services. The logic of selecting only freshmen students was to increase the range of language aptitude within the sample. These same subjects were also used in Experiment III. Whether one was a visual or aural subject was determined by a table of random numbers with ten men and ten women placed into each treatment group.

Materials

The pictures in the vocabulary items were selected from nouns listed as AA in the Thorndike-Lorge frequency count. Pictures were drawn in India ink on 5 x 8 cards. The Spanish words were printed with a Wricoprint Set, Guide Number VC 1-2P with pen code Number 3

Apparatus

As in Experiment I, the visual materials were presented with the Kardex and the auditory materials were played through the Language Master.

Results

The scoring of the vocabulary items required a judgment by the experimenter as to how well the subject's written or spoken response approximated the ideal response. The reliability of E's scoring decisions was estimated by asking two judges to independently score a sample of responses. This was done by randomly selecting eight subjects, and taping their spoken responses. The result was that the judges disagreed about 1% of the time for written responses and about 5% for the spoken responses.

Again, as in Experiment I, total error was divided into unique error and perseverative error.

Picture vocabulary learning. The results were almost identical to the findings for vocabulary learning in Experiment I. All differences were in favor of the "visual subjects."[7] The following generalizations were abstracted from Tables 13 and 14.

1. Initial learning of picture vocabulary - List 9.

Type of Error	P Value
Total	NSD
Unique	NSD
Perseveration	<.025

2. Relearning of picture vocabulary - List 9.

Type of Error	P Value
Total	NSD
Unique	<.025
Perseveration	NSD

---

[7] In List 9, visual subjects initially learned the picture vocabulary items by vision and aural subjects by audition. However, in List 10, the roles were reversed with the visual subjects initially learning aurally and relearning visually, while aural subjects initially learned visually and relearned aurally. To be consistent with the format of reporting in Experiment I, "visual subjects" here means those subjects who learned Lists 9 and 10 initially by vision, and relearned by audition.

Table 13

Picture Vocabulary - List 9: Experiment II

		Visual Subjects		Aural Subjects
Total Error in Initial Learning				
	$\bar{X}$	8.00		10.00
	σ	7.06		7.10
	t		.893	
	P		NSD	
Total Error in Relearning				
	$\bar{X}$	.50		.85
	σ	.87		.85
	t		.405	
	P		NSD	
Unique Error in Initial Learning				
	$\bar{X}$	4.20		4.65
	σ	2.34		2.24
	t		.63	
	P		NSD	
Unique Error in Relearning				
	$\bar{X}$	.35		.80
	σ	.57		.81
	t		2.04	
	P		$<.025$	
Perseverative Error in Initial Learning				
	$\bar{X}$	3.80		5.35
	σ	5.20		5.30
	t		2.22	
	P		$<.025$	
Perseverative Error in Relearning[a]				

[a] There were not enough errors for a meaningful computation.

Table 14

Picture Vocabulary - List 10: Experiment II

	Visual Subjects		Aural Subjects
Total Errors in Initial Learning			
$\overline{X}$	14.55		20.90
σ	10.70		12.93
t		1.69	
P		$<.05$	
Total Errors in Relearning			
$\overline{X}$	2.35		4.10
σ	3.58		3.10
t		.522	
P		NSD	
Unique Error in Initial Learning			
$\overline{X}$	6.95		6.45
σ	1.86		2.11
t		.620	
P		NSD	
Unique Error in Relearning			
$\overline{X}$	1.20		2.75
σ	1.44		1.64
t		3.16	
P		$<.005$	
Perseverative Error in Inital Learning			
$\overline{X}$	8.10		13.95
σ	8.91		11.46
t		1.80	
P		$<.05$	
Perseverative Error in Relearning[a]			

[a] There were not enough errors for a meaningful computation.

3. Initial learning of picture vocabulary - List 10.

Type of Error	P Value
Total	$<.05$
Unique	NSD
Perseveration	$<.05$

4. Relearning of picture vocabulary - List 10.

Type of Error	P Value
Total	NSD
Unique	$<.005$
Perseveration	NSD

Experiments I and II established that visual subjects had significantly fewer mean perseverative errors in initial vocabulary learning and significantly fewer mean unique errors in vocabulary relearning. The "total error" classification did not yield consistent results between Experiments I and II

5. Visual and aural subjects showed positive transfer when they relearned vocabulary items through a different sense modality When the histograms in Figures 5 and 6 are compared to Figures 7 and 8 for information on the amount of transfer, it can be seen that there is approximately 60% mean reduction in all categories of error.

Again, as in Experiment I, Lists 1 and 2 were used to determine: (a) the homogeneity of language learning ability for visual and aural subjects; (b) the validity of the work sample measures in predicting performance in language learning; and (c) the sensory dominance in the subjects.

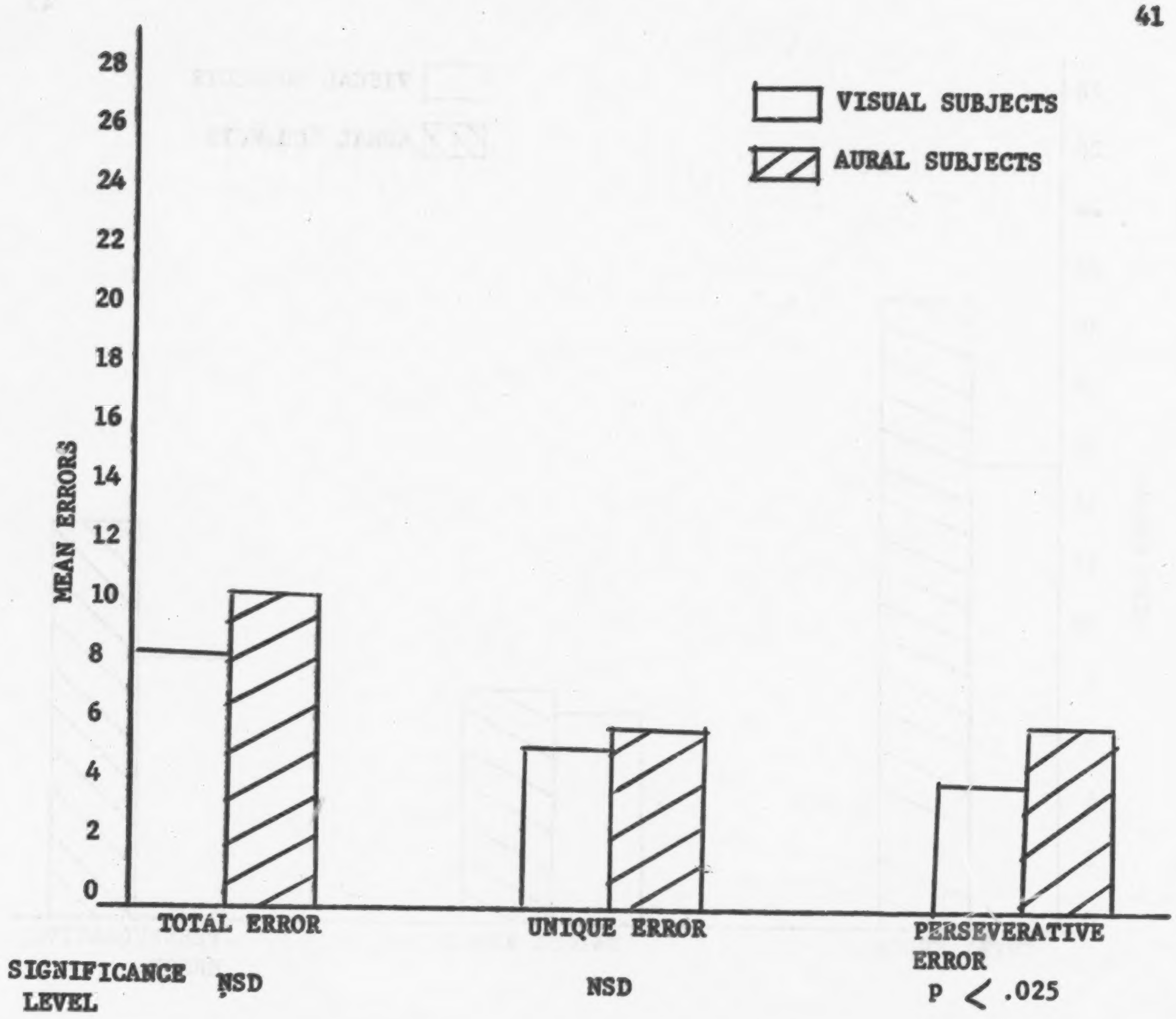
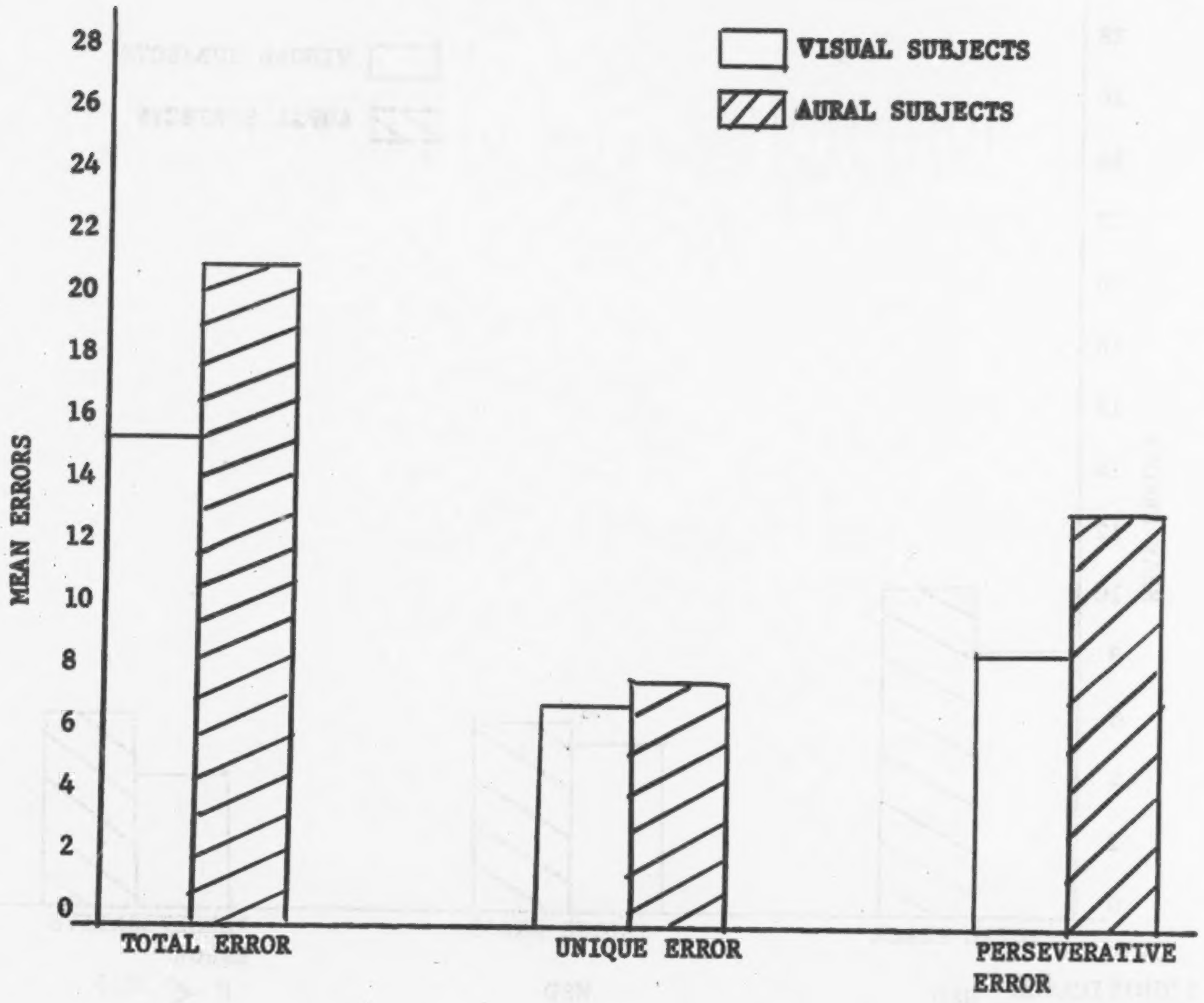


Figure 5. Initial learning of picture-Spanish items in List 9.



SIGNIFICANCE LEVEL $p < .05$ NSD $p < .05$

Figure 6. Initial learning of picture-Spanish items in List 10.

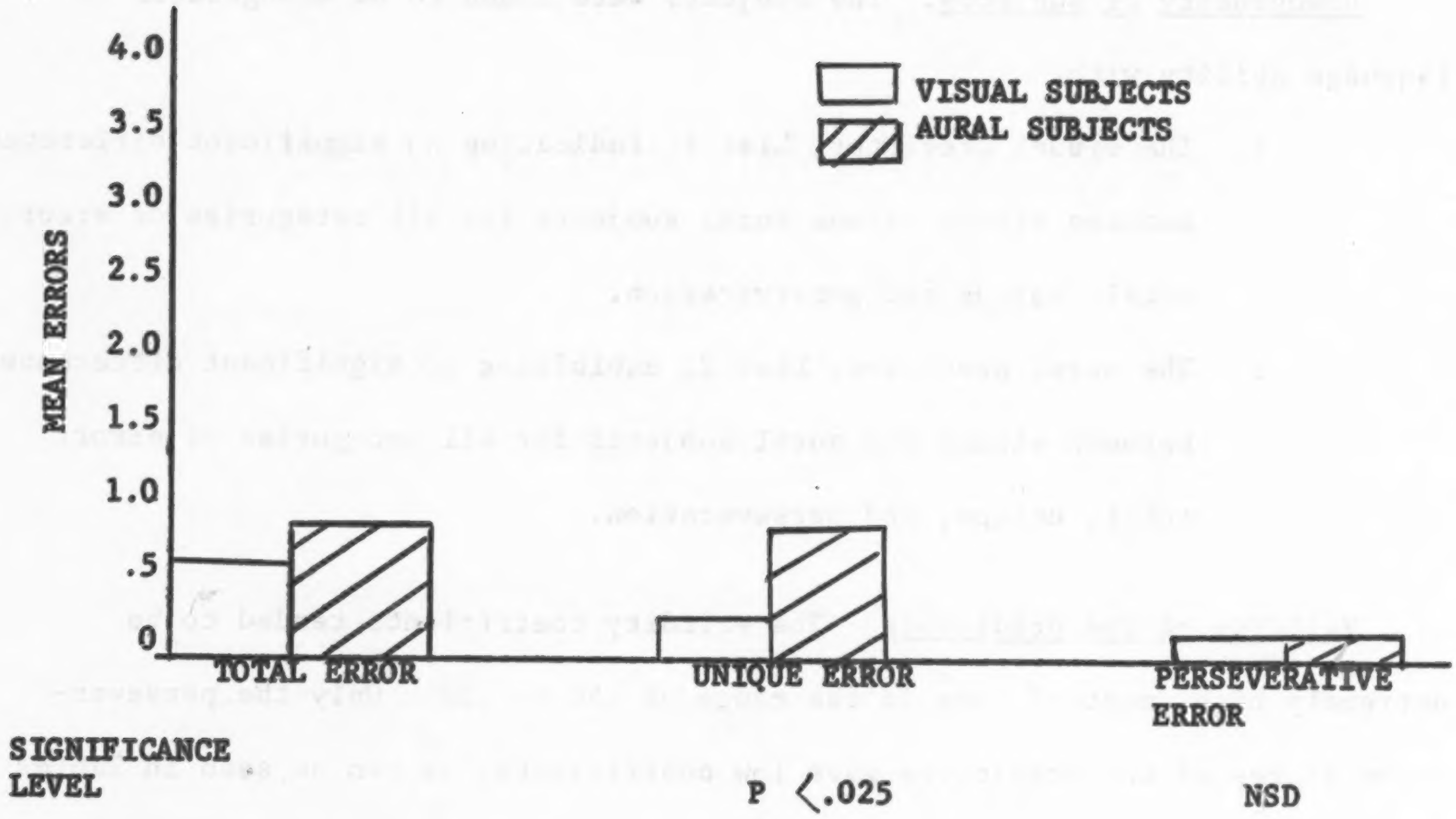


Figure 7. Relearning of picture-Spanish items in List 9.

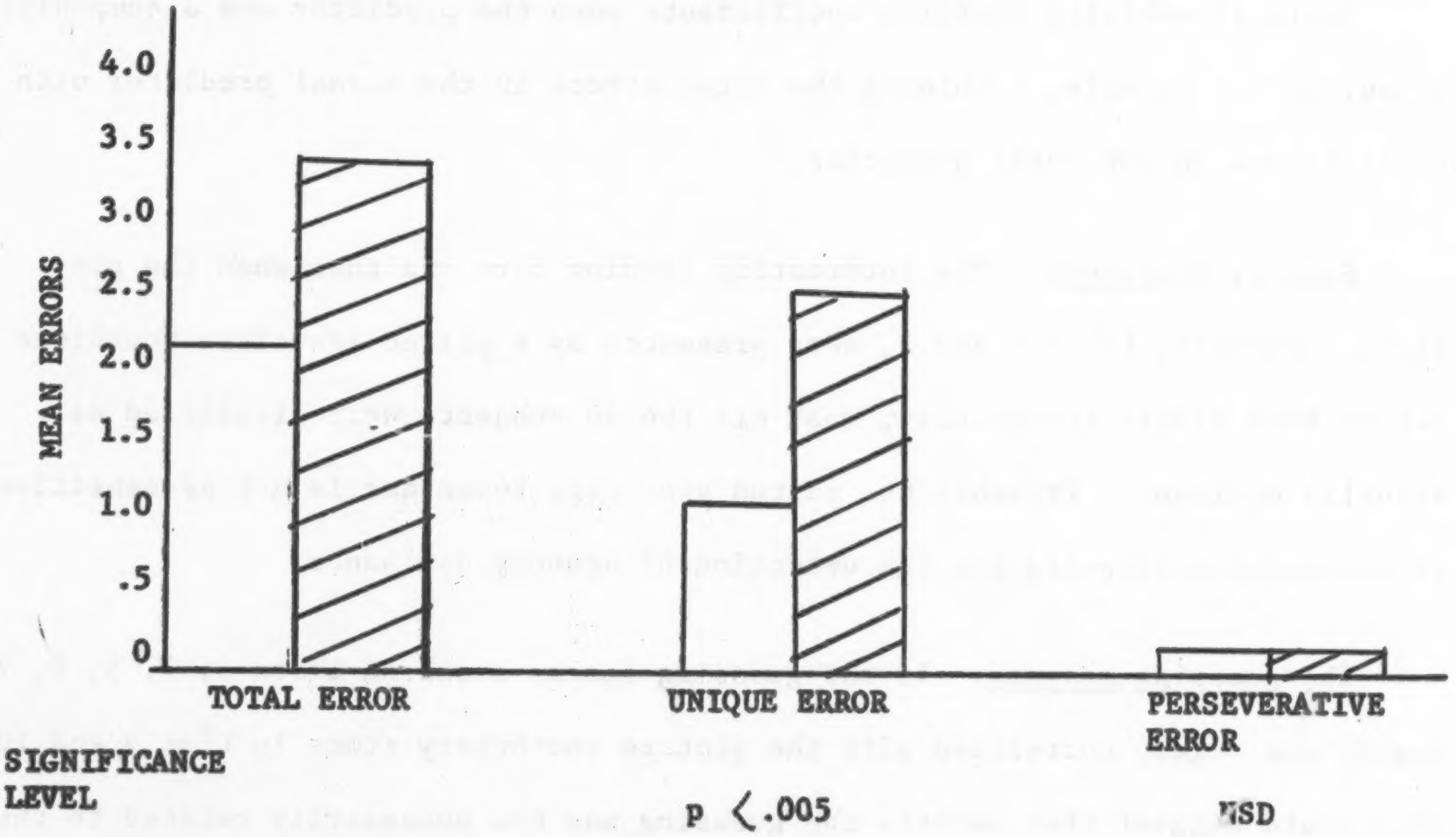


Figure 8. Relearning of picture-Spanish items in List 10.

Homogeneity of subjects. The subjects were found to be homogeneous in language ability with:

1. The visual predictor, List 1, indicating no significant differences between visual versus aural subjects for all categories of error: total, unique and perseveration.
2 The aural predictor, List 2, exhibiting no significant differences between visual and aural subjects for all categories of error: total, unique, and perseveration.

Validity of the predictors. The validity coefficients tended to be extremely high, most of them in the range of .50 to .80. Only the perseveration scores of the predictors gave low coefficients, as can be seen in Tables 15 and 16.

Table 17 exhibits validity coefficients when the predictor was a composite score, as for example, combining the total errors in the visual predictor with total errors in the aural predictor.

Sensory dominance. The interesting finding here was that when the predictor measures, Lists 1 and 2, were presented by a paired associate technique rather than simple recognition, most all the 40 subjects were classified as visually dominant. Probably the paired associate technique is not as sensitive as recognition learning for the detection of sensory dominance.

The guessing measure. If the guessing score, based on Lists 3, 4, 5, 6, 7, and 8, was highly correlated with the picture vocabulary items in List 9 and 10, this would suggest that perhaps the guessing was not necessarily related to the specific vocabulary items learned. The correlation coefficients, displayed in Table 18, showed a substantial relationship between guessing and the learning of the picture vocabulary items only for the aural subjects.

Table 15

Validity Coefficients for the Visual Predictor: Experiment II

Criterion Measures	Visual Predictor (List I)					
	Visual Subjects[a]			Aural Subjects		
	T[b]	U	P	T	U	P
Picture Vocabulary (List 9)						
T	.650***			.720***		
U		.269			.481*	
P			.270			.425*
Picture Vocabulary (List 10)						
T	.859***			.810***		
U		.671***			.712***	
P			.759***			.249

Note:
* Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] Note that the visual subjects in list 9 were the aural subjects in list 10, and conversely the aural subjects in list 9 were the visual subjects in list 10.

[b] T = Total Error
U = Unique Error
P = Perseverative Error

Table 16

Validity Coefficients for the Aural Predictor: Experiment II

Criterion Measures	Aural Predictor (List 1)					
	Visual Subjects[a]			Aural Subjects		
	T[b]	U	P	T	U	P
Picture Vocabulary (List 9)						
T	.367			.680***		
U		.442*			.642***	
P			.118			.659***
Picture Vocabulary (List 10)						
T	.711***			.638***		
U		.577***			.808***	
P			.213			.592***

Note: * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] Note that the visual subjects in list 9 were the aural subjects in list 10, and conversely the aural subjects in list 9 were the visual subjects in list 10.

[b] T = Total Error
U = Unique Error
P = Perseverative Error

Table 17

Validity Coefficients for the Composite Predictors: Experiment II

Criterion Measures	Composite Predictors (List 1 and 2) Visual Subjects T[a]	 Visual Subjects U	 Aural Subjects T	 Aural Subjects U
Picture Vocabulary (List 9)				
T	.302		.700***	
U		.391*		.805***
Picture Vocabulary (List 9 and 10)				
T	.854***		.865***	
U		.800***		.765***

Note: * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] T = Total Error
U = Unique Error

Table 18

Correlations Between the Guessing Score[a] and Performance on the Picture Vocabulary List 9: Experiment II

Criterion Measures	Visual Subjects	Aural Subjects
Picture Vocabulary (List 9)		
T[b]	-.270	-.500*
U	-.278	-.610***
P	-.240	-.408*

Note: * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] Guessing score was the number of correct guesses.

[b] T = Total Error
U = Unique Error
P = Perseverative Error

EXPERIMENT III

So far the intersensory findings have held when the learning demanded recall or recognition. Experiment III was designed to determine if the intersensory results would hold for recall learning when the stimuli were English words rather than pictures. Essentially, Experiment III was a replication of I with the exception that the learning was by paired associate rather than recognition.

Procedure

Vocabulary learning. Subjects learned each vocabulary list in this fashion:

TRAINING:		TEST:	
Trial 1		Trial 1 + n	
Stimulus	Time	Stimulus	Time
1. English word	1 second	1. English word	1 second
2. Spanish word	1 second	2. Nothing (S wrote or pronounced his response)	5 seconds
		3. Spanish word	1 second

Items, presented randomly on each trial, were eliminated from the list as the subject responded correctly twice in a row. After learning a list of vocabulary items, S was asked to translate two sentences which were derived from the list just acquired.

As in Experiment I, the sequence was vocabulary learning through one sense modality, then translation of sentences; vocabulary relearning through a different sense modality followed by the translation of a different set of sentences.

Recall and recognition measure. After vocabulary Lists 4, 5, 6, 7, and 8 were learned, each subject was administered a recall and recognition measure. The experimental design is schematically represented in Figure 9.

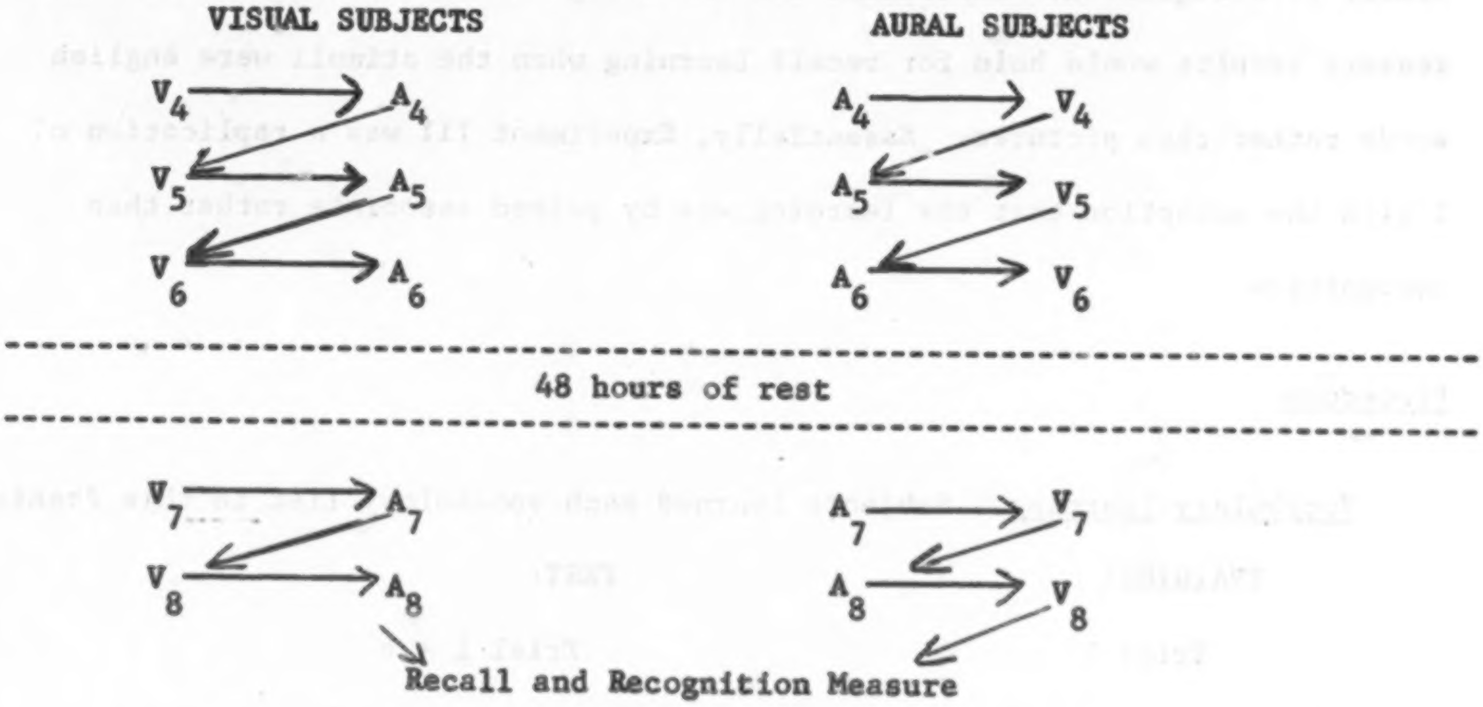

VISUAL SUBJECTS
AURAL SUBJECTS
V4
A4
V5
A5
V6
A6
A4
V4
A5
V5
A6
V6
48 hours of rest
V7
A7
V8
A8
A7
V7
A8
V8
Recall and Recognition Measure

Figure 9. Schematic diagram of the experimental design for Experiment III.

Materials and Apparatus

The materials and apparatus were identical to those described in Experiment I.

Subjects

The subjects were the same individuals who participated in Experiment II. Attrition reduced the N from 40 to 36. Visual subjects were reduced to 17 and aural subjects were reduced to 19.

Results

Vocabulary learning. Basically, the intersensory findings were the same as Experiments I and II. All differences were in favor of the visual subjects. The following generalizations have been abstracted from Tables 19, 20, and 21.

Table 19

Vocabulary Learning: Experiment III

		List 4,5,6,7		List 8	
		Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Total Error in Initial Learning					
	$\overline{X}$	37.59	58.05	9.06	14.42
	σ	19.07	35.15	6.70	9.35
	t	2.20		1.99	
	P	$<.025$		$<.05$	
Total Error in Relearning					
	$\overline{X}$	10.76	26.32	.88	5.00
	σ	7.42	19.92	1.13	4.56
	t	3.17		3.81	
	P	$<.005$		$<.0005$	

Table 20

Vocabulary Learning: Experiment III

		Lists 4,5,6,7		List 8	
		Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Unique Errors in Initial Learning					
	$\bar{X}$	19.35	21.05	5.29	5.89
	σ	5.88	7.26	2.76	1.74
	t	.77		.77	
	P	NSD		NSD	
Unique Errors in Relearning					
	$\bar{X}$	8.41	15.68	.765	3.32
	σ	4.55	7.92	.876	2.00
	t	3.46		5.07	
	P	$< .005$		$< .001$	

2

Table 21

Vocabulary Learning: Experiment III

	Lists 4,5,6,7		List 8	
	Visual Subjects	Aural Subjects	Visual Subjects	Aural Subjects
Preseverative Errors in Initial Learning				
$\bar{X}$	18.12	37.00	3.76	9.53
σ	14.32	28.72	4.28	8.02
t	2.55		2.75	
P	$<.025$		$<.005$	
Perseverative Errors in Relearning				
$\bar{X}$	2.35	10.63	.12	1.68
σ	3.45	13.36	.47	3.05
t	2.61		2.20	
P	$<.025$		$<.025$	

1. Initial learning of vocabulary - Lists 4, 5, 6, 7

Type of Error	P Value
Total	<.025
Unique	NSD
Perseveration	<.025

2. Relearning of vocabulary - Lists 4, 5, 6, 7

Type of Error	P Value
Total	<.005
Unique	<.005
Perseveration	<.025

Experiments I, II, III established that visual subjects had significantly fewer mean perseveration errors in initial vocabulary learning and significantly fewer mean unique errors in vocabulary relearning. The "total error" classification did not give reliable results between Experiments I, II, and III.

3. Visual and aural subjects showed positive transfer when they relearned vocabulary items through a different sense modality. There was approximately 60% reduction in error or more for all error categories for visual and aural subjects.

4. The results reported were for a simultaneous visual presentation of items in Lists 4, 5, 6, and 7. List 8, set up for a sequential visual presentation, produced the following results which can be examined in detail in Tables 19, 20 and 21. All differences favored the visual subjects.

    a. Initial learning of vocabulary - List 8.

Type of Error	P Value
Total	<.05
Unique	NSD
Perseveration	<.0005

b. Relearning of vocabulary - List 8.

Type of Error	P Value
Total	$< .0005$
Unique	$< .001$
Perseveration	$< .025$

Again, as in Experiment I, whether the visual presentation was simultaneous or sequential made no difference in the basic intersensory results.

Sentence translations. As seen in Table 22, after the initial learning of vocabulary items, visual subjects

1. Identified significantly more mean words in the sentences at $P < .05$, and
2. Discerned significantly more mean sentence meanings at $P < .01$.

After the relearning of vocabulary items, the visual subjects were not significantly better in the identification of words within sentences nor did they discern significantly more sentence meanings.

Retention measures. Table 23 shows that there were no significant differences between visual and aural subjects in the mean number of vocabulary items recalled or recognized.

Homogeneity of subjects. Visual and aural subjects were homogeneous in visual and aural learning ability as measured by the predictors, vocabulary Lists 1 and 2.

Table 22

Sentence Translations: Experiment III

	Visual Subjects	Aural Subjects
Number of Words Identified Within the Sentences After Initial Learning		
$\bar{X}$	23.81	20.33
σ	3.19	4.90
t	1.91	
P	$<.05$	
Number of Words Identified Within the Sentences After Relearning		
$\bar{X}$	23.94	25.33
σ	5.03	4.40
t	.72	
P	NSD	
Number of Sentence Meanings Which Were Understood After Initial Learning		
$\bar{X}$	7.31	5.00
σ	1.72	2.36
t	2.56	
P	$<.01$	
Number of Sentence Meanings Which Were Understood After Relearning		
$\bar{X}$	5.50	5.78
σ	2.03	2.39
t	1.19	
P	NSD	

Table 23

Retention Measures: Experiment III

	Visual Subjects	Aural Subjects
Recall of vocabulary items in lists 4,5,6,7.		
$\bar{X}$	21.06	20.63
σ	6.25	5.64
t	.216	
P	NSD	
Recognition of vocabulary items in lists 4,5,6,7.		
$\bar{X}$	38.89	38.74
σ	1.13	1.21
t	.38	
P	NSD	

Validity of predictors. The validity coefficients were high and significant as can be seen in Table 24. Reliability coefficients for the criterion measure of vocabulary items is presented in Table 25.

The guessing measure. Again, as in Experiments I and II, the guessing measure tended to correlate substantially with most of the language performance measures. The coefficients have been displayed in Table 26.

Discussion

Intersensory Differences

The evidence is quite definitive in showing that if one learns language materials first by vision, and then relearns by audition, there will be:

1. A significant acceleration in initial learning,
2. A significant acceleration in relearning,
3. A significant transfer to syntactic comprehension, and
4. No comparative restriciton on recall and recognition retention measures.

Of course the linguist might object to these conclusions based on the fact that the criterion of acquisition was learning rather than accuracy in pronunciation. It would be interesting to replicate the experiments to discover if the sequence of vision followed by audition has a disruptive effect on pronunciation.

At this time, however, the most interesting question is; What theoretical model can explain the learning differences between vision and audition? The following are some possible explanations for the intersensory differences:

Table 24

Validity Coefficients for the Single Predictors: Experiment III

Criterion Measure (Lists 4,5,6,7)	Visual Predictor (List 1) Initial Learning T	U	Relearning T	U
Visual Subjects (N=17)				
T[a]	.622***		.949***	
U		.599**		.586**
Aural Subjects (N=19)				
T	.885***		.690***	
U		.770***		.694***

Note: * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] T = Total Error
U = Unique Error

Table 25

Reliability Coefficients for the Vocabulary Learning: Experiment III

	Visual Subjects N=17	Aural Subjects N=19
Initial Learning		
T[a]	.909	.872
U	.805	.816
P	.851	.837
Relearning		
T	.683	.823
U	.838	.862
P	.836	.838

Note: All coefficients are significant beyond the .005 level.

All correlations were adjusted by the Spearman Brown formula for split-halves.

Odd lists (5 & 7) were correlated against even lists (4 & 6).

[a]T = Total Error
U = Unique Error
P = Perseverative Error

Table 26

Correlations Between the Guessing Score[a] and Each of the Performance Measures: Experiment III

	Visual Subjects	Aural Subjects
	(N=17)	(N=19)
Initial Vocabulary Learning		
T[b]	-.578**	-.740***
U	-.514*	-.713***
P	-.392	-.721***
Relearning of Vocabulary		
T	-.594**	-.660***
U	-.491*	-.763***
P	-.640***	-.540**
	(N=16)[c]	(N=9)
Sentences, After Initial Learning		
# Words Correct	.088	.701*
# Meanings	.373	.611*
Sentences, after Relearning		
# Words Correct	.491*	.880***
# Meanings	.253	.701*
	(N=17)	(N=19)
Recall	.176	.721***
Recognition	.572**	.058
Visual Predictor (T)	-.649***	-.651***
Aural Predictor (T)	-.362	-.600***

Note: * Significant beyond .05
** Significant beyond .01
*** Significant beyond .005

[a] The guessing score and the performance measures were based on lists 4,5,6,7,8. The guessing score was the number of correct guesses.

[b] T = Total Error
U = Unique Error
P = Perseverative Error

[c] An administrative mistake forced the discarding of some data.

The response construction hypothesis. The explanation here is that the written responses required for visual learning were more highly developed in ordinary experience than the spoken responses for the aural learning. The alpha characters in the visually presented Spanish words are almost identical to the English alphabet. While it is easy to construct the written characters in Spanish, it may be more difficult to generate many of the sounds in Spanish. The difficulty in response construction is biased against the spoken word. This argument makes sense for Experiment III, but does not seem to hold for Experiment I where the response task was merely to make a discrimination between two given responses.

The signal to receptor hypothesis. Before attempting to explain why visual learning is better than aural learning in adults, it would be interesting to examine the language behavior of these adults when they were children. If we analyze children's language learning we make the strange observation that the intersensory relationships are exactly the reverse of the optimal sequence in adult language learning. Children learn listening comprehension and spoken language before they learn to read and write. If the child's language learning can be called "the natural way," then perhaps the adult too should learn new languages in the pattern of children, by first learning the spoken language, then learning to read and write.

The puzzle of why children learn listening comprehension and speaking before reading and writing can be explained rather neatly with a signal to receptor model which has been diagrammed in Figure 10. The model states that only the signal to receptor relationship in audition permits language learning in the young child. For example, notice that in Figure 10

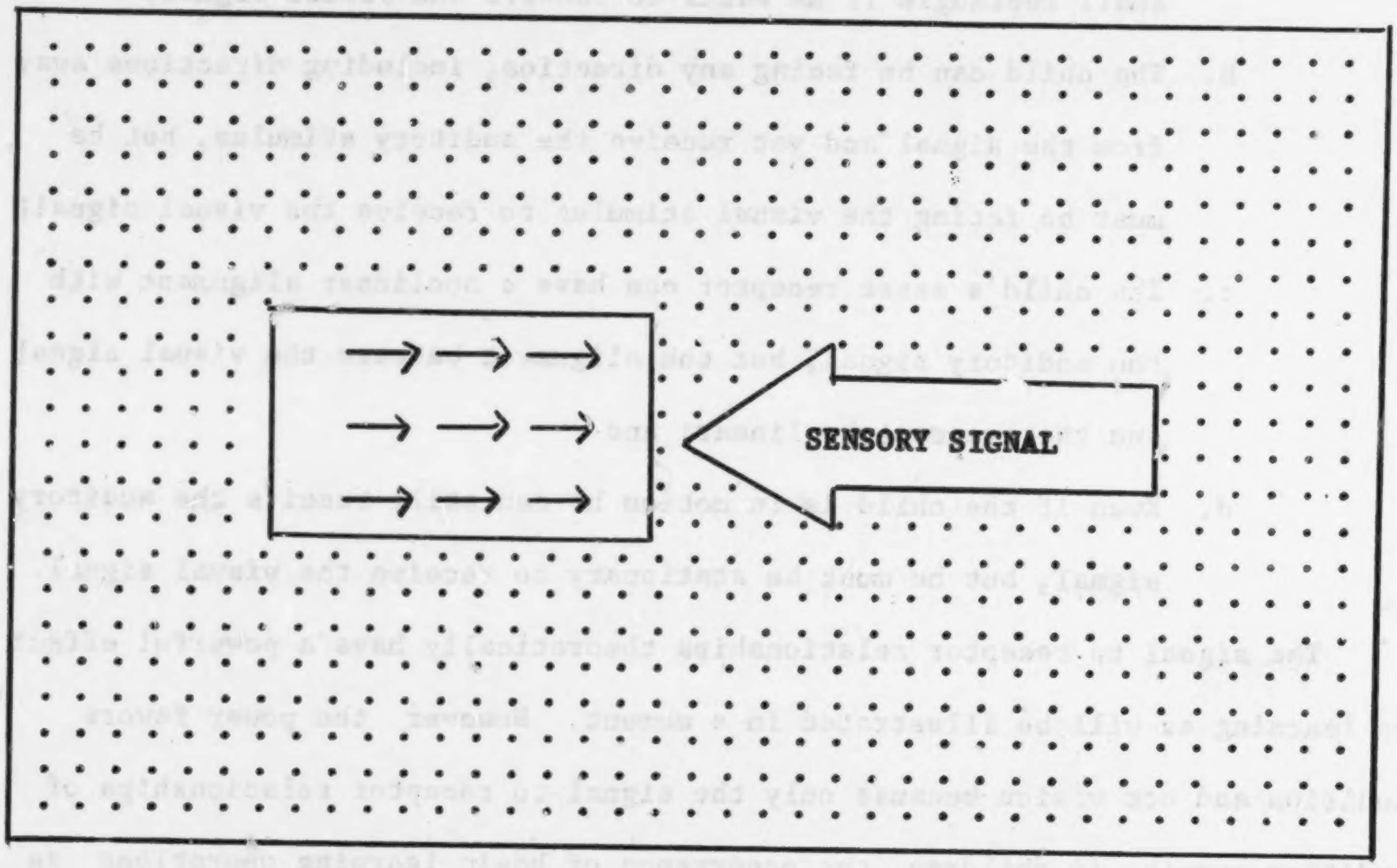

SENSORY SIGNAL

FIGURE 10

Diagram of the Signal

to Receptor Model

a. The child can be at any point in the large rectangle and still receive the auditory signal, but the child is restricted to the small rectangle if he wants to receive the visual signal;

b. The child can be facing any direction, including directions away from the signal and yet receive the auditory stimulus, but he must be facing the visual stimulus to receive the visual signal;

c. The child's sense receptor can have a nonlinear alignment with the auditory signal, but the alignment between the visual signal and the eye must be linear, and

d. Even if the child is in motion he can still receive the auditory signal, but he must be stationary to receive the visual signal.

The signal to receptor relationships theoretically have a powerful effect on learning as will be illustrated in a moment. However, the power favors audition and not vision because only the signal to receptor relationships of audition permit, in children, the occurrence of basic learning operations as contiguity, feedback, and reinforcement. As an illustration, Jeffrey, age 1 1/2, has toddled to the stove and is on his toes trying to reach the coffee pot bubbling on the burner. Mother cries, "No, Jeff, it's hot!" Notice that although the child is facing away from the auditory signal, the signal is in immediate contiguity with the behavior of reaching for the stove. Now Jeff touches the coffee pot and flicks his hand back whimpering, "...hot, hot." Mother scolds, "Yes, it's hot. I told you it was hot." Within seconds, (a) the child approached a stimulus, the stove, (b) received mother's first auditory signal containing information about the stimulus, (c) made contact with the stove, (d) emitted a verbal response derived from the auditory signal received seconds before, and (e) received feedback and reinforcement from mother's second auditory signal. The important learning operations of contiguity, feedback, and reinforcement occurred even though the infant was in motion and facing away from the signal. It is not surprising, then, that children learn language first by audition. In fact, it seems clear that for small children, vision is almost empty of power for language learning since the probabilities for the presence of basic learning operations are reduced to a minimum. Or we might look at the problem from Professor B. F. Skinner's operant conditioning model. Since young children are "perpetual motion machines," only the auditory signal can have the property of immediate reinforcement necessary to shape verbal language behavior.

If the analysis is true, then it follows that there is nothing within the neutral mechanism of vision or audition which explains why children learn speaking before reading and writing. The power of audition is in the properties of the signal to sense receptor relationships.

From the model we can infer that audition's special power in children's language learning, should disappear for adults. The reason is that the adult can restrict himself to the smaller rectangle for extended periods of time. Another important factor, of course, is that the adult has developed the neuromuscular coordination necessary to manipulate a pencil. Notice that the signal to receptor model predicts that audition should have no special advantage over vision for the adult's language learning. What remains as an unsolved problem is: Why is it that for adult language learning, experiments demonstrated that vision had a special advantage over audition?

The sound dependency hypothesis. If vision is empty of power for the child's language learning, why does it seem so important in adult language learning? A partial answer to this is that vision is not empty of power for the child's language learning.

The sound dependency hypothesis states that sound is dependent on vision for meaning, but vision can be independent of sound. For example, if a child were to live from birth in a sensory vacuum, with only auditory stimulation, it is probable that sounds would never be anything but noise to the child. No language learning would occur. On the other hand, if a child were to exist from birth in a sensory vacuum with only visual stimulation, it seems quite possible that one could acquire language skill in reading and writing.[8]

How can vision have power for language learning and at the same time have no power for language learning? The paradox can be resolved if we realize that the receptor to signal model only attempts to explain: (a) response acquisition and (b) the stimulus-response connection. The model does not discuss properties of the stimulus. As it turns out, the stimulus tends to be visual, as in Jeff's mild trauma, the stimuli of stove and coffee pot were visual. Without the visual properties of the stimulus or an appropriate substitute as the tactile sense, the sound signals would have been meaningless noise.

For young children, vision is a crucial property of the stimulus, but audition is critical in response acquisition and the stimulus-response connection. Later in the child's development, the visual properties of the stimulus become less critical when spoken language becomes advanced enough for reification of aural symbols. Then spoken words become stimuli in place of exclusively visual stimuli.

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[8] Of course the skill in reading and writing could only occur when the child was old enough to restrict himself to the small rectangle of Figure 10, and had the neuro-muscular control to use a pencil.

The restricted field hypothesis. Since adults can restrict themselves to the small rectangle in Figure 10 for extended time periods and since the adult neuro-muscular motor development permits them to manipulate notation on paper, the learning of reading and writing is possible. This means that visual learning can be as effective theoretically as aural learning. Audition may have a special advantage for children, but this power vanishes for the adult. In fact, the restriction to the smaller rectangle of Figure 10, as is true in classroom learning or automated machine teaching, may well reverse the sensory effects by giving vision a special advantage.

Children learn auditory language in an unrestricted field consisting of an intricate network of life settings, and they learn visual language in a restricted field, the classroom. It is possible, although the explanation is rather vague, that because one's second language is learned in the restricted field of the classroom or teaching machine, the setting is somehow compatible with visual learning and in conflict with aural language learning.

The sense dominance hypothesis. The advantage of vision over audition in adult language learning may be simply explained as the result of having more visually dominant people in the experiments. This is especially plausible since the samples were selected from a college population.

Evidence has been presented from Experiment I which suggests that of those who initially learned by vision, the visual dominants did better than aural dominants. Conversely, of those who initially learned by audition, the aural dominants did better than the visual dominants.

If sense dominance is important then there is another way of evaluating this factor. If we examine the data of subjects who were visually dominant, we should find that those who learn language items initially by vision performed better than those who learned initially by audition. Conversely, of the aurally dominants, those who learned initially by audition did better than those who learned initially by vision. Table 27 presents documentation from Experiment I[9] to support the expectation.

The small Ns in each group limit the conclusiveness of the data. However, the data do suggest that when subjects are grouped according to sensory dominance, one can predict the outcome of language learning. Future research may demonstrate that the advantage of vision over audition in adult language learning was an artifact of sampling from a college population where there was a greater proportion of visual dominants than aural dominants.

The figure-ground hypothesis. The differences between vision and audition may have been a function of figure ground differentiation. The printed letters on a card are clear figures sharply distinguished from the background of the card. On the other hand, sounds of foreign words are blurred figure-ground in that the phonemes are not always sharply distinguishable from each other within the same word or between words. This may explain why the aural subjects had significantly more perseverative error in learning the first time by listening. Repeating the same mistakes may be a sign of difficulty in the differentiation of sounds within words and between words.

If this hypothesis holds, then perhaps the value of initially learning language by vision is that in relearning by audition the perception of the spoken language has more detailed figure ground differentiation.

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[9] The data were in unique errors.

Table 27

Vocabulary Learning for Subjects

With Different Sensory Dominance: Exp. III

	Aurally Dominant		Visually Dominant	
	Visual Subjects (N=8)	Aural Subjects (N=7)	Visual Subjects (N=11)	Aural Subjects (N=7)
Unique error in initial learning of vocabulary. (Lists 3,4,5,6,7)				
$\bar{X}$	20.12	17.71	17.27	21.85
σ	3.89	3.73	5.10	6.03
t	1.23		1.66	
P	$<.15$		$<.10$	

The simultaneity of input hypothesis. If a stimulus is visually exposed for precisely the same amount of time required for auditory exposure, the probability is that the input into the aural receptor will be 1 in comparison to an input into the visual receptor of 1 + n. The reason for this is that the auditory stimulus is presented to the receptor sequentially, word by word, while the visual stimulus is presented simultaneously. This means that the visual receptor controls the rate of sequencial input; or expressed differently, the eye has the option of scanning the stimulus 1 + n times before the stimulus is removed from view. This problem has been experimentally evaluated in the present paper and shown to be relatively unimportant in influencing intersensory learning differences.

However, there is another dimension to the sequential versus simultaneous input problem which should be considered. Sperling (1960) has demonstrated that people can visually receive a matrix of unfamiliar information, about nine bits, in milliseconds of time. This, considered with the research literature in reading, suggests that the visual channel can receive and evaluate more information per unit of time than audition, and perhaps more complex information can be processed per unit of time. For example, a picture or a diagram presented briefly may communicate a complicated network of information which would be impossible to communicate in the same time with the spoken language. The little understood property of input simultaneity which is unique to vision may account in part for our dependency on this sensory mode.

None of the hypotheses discussed are completely adequate in explaining the experimental findings. Any theory proposed should explain why aural subjects had more perseverative error in the learning vocabulary by listening, and significantly more unique errors when they visually relearned the vocabulary. A powerful theory will also explain the relationship of guessing to language learning.

The Guessing Phenomenon

The phonetic symbolism hypothesis. The literature contains reports of a phenomenon similar to guessing (Sapir, 1929; Newman, 1933; Bentley and Varon, 1933; Brown, Black, and Horowitz, 1955). What has been found is that when subjects were presented with English synonym-antonym pairs such as sharp-blunt, and asked to match these with their Chinese counterparts of tun- k'uai, the matching was significantly more accurate than would be expected by chance. The explanation, labeled the phonetic symbolism hypothesis, was that historically when spoken language was invented, sounds were not selected randomly to represent concepts, but rather were systematically selected because they suggested particular concepts.

The phonetic symbolism hypothesis, however, does not easily fit our data because no statement can be derived from the model to explain: (a) why individuals differ in their ability to discern universal sound-concept relationships, and (b) why should difference in this ability be related to the language learning process?

The prior learning hypothesis. The explanation here states that the guessing behavior represented a measure of the subjects' prior learning of the language. This interpretation is not completely convincing since (a) there was no evidence that our subjects had prior exposure to Spanish, and (b) all of our subjects in Experiments II and III reported that most of their choices between pairs of foreign terms were purely guesses.[10]

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[10] Ss in Experiment I were not questioned as to how many items were actually guessed.

The transfer hypothesis. Here the explanation is that the decisions between the foreign word pairs were not guesses but were determined by positive transfer from prior learning of a similar language such as French or Latin. This hypothesis was tested by examining the high school transcripts of a group of freshman college students, the aural subjects of Experiment III (N = 19). If those with high scores on the guessing measure had more exposure to French or Latin, or higher grades in these languages than those with low scores on the guessing measure, then the hypothesis was supported. The evidence did not support the transfer hypothesis. However, a definitive test of the hypothesis would be to design a new study using languages rarely studied by American students such as Japanese, Russian, Turkish, or Arabic.

SUMMARY

Any theoretical model of programmed learning for languages is dependent on information concerning sensory interrelationships. Three experiments were designed to explore the effects of language learning through vision versus audition. Specifically, the purpose was to determine (a) the effects of learning symbolic material, vocabulary items in Spanish, through one sense modality, then relearning the same material through a different sense modality, and (b) the transfer effects from elements (vocabulary items) to patterning of the elements (syntactic material consisting of sentences and stories which were composed from the vocabulary items).

Two samples of undergraduate college students (N = 80) with no history of training in Spanish, learned and relearned 92 vocabulary items, under a range of conditions including: (a) paired associate versus recognition learning, (b) pictures versus English words as stimuli, and (c) simultaneous versus sequential presentation of visual materials. Active acquisition of the languages was required in that all responses were in the foreign language and were either written or spoken. Novel methodological techniques which allowed random access to the visual and aural materials were described in detail.

The results were that under all conditions, subjects who learned visually and relearned aurally achieved a superior performance in comparison to subjects who learned aurally and relearned visually. Superior performance means: (a) significantly less perseverative error in initial learning, (b) significantly less unique error in relearning, and (c) significantly greater transfer to syntactic comprehension. Other factors found to have an important relationship to language learning were sensory dominance and guessing behavior.

A series of theoretical constructs were suggested as possible explanations for the intersensory differences.

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APPENDIX A

VOCABULARY ITEMS

Sample Items

			Distractor Items Used in Experiment I
1.	THOSE WHO	LOS QUE	BOSQUE
2.	WE GAVE	DIMOS	DAMAS
3.	TICKETS	ENTRADAS	ENTRE DOS
4.	COURTESY	CORTESÍA	CONDESA
5.	(THEY) LEARN	APRENDEN	ATIENDEN
6.	BAD HUMOR	MAL HUMOR	PUNDONOR
7.	TO	A	AHÍ
8.	TO WORK	TRABAJAR	TRAMITAR
9.	WE SAY	DECIMOS	DÉCIMO
10.	WE GIVE	DAR Damos	MAR
11.	HE KISSED HER	LA BESÓ	LA PESO
12.	WHO	QUE	AQUÍ

List I

1.	THAT	ESO	OSO
2.	WAS	FUE	FE
3.	FOR	PARA	PARO
4.	WHAT	QUÉ	AQUÍ
5.	PEOPLE	(LA) GENTE	(EL) GENIO
6.	UP	ARRIBA	ARRUGA
7.	SO	ASÍ QUE	CACIQUE
8.	OTHER	OTRA	OCHO
9.	GOING	YENDO	YERNO
10.	WANT	QUIERE	GÜIRO

List 2

1.	TO (TOWARD)	HACIA	ASA
2.	THEY	ELLOS	OLLAS
3.	(HE) CAME	VINO	VIDA
4.	ACT	ACTÚAN	ACTUAL
5.	WHO	QUIÉN	QUEMA
6.	TIME	TIEMPO	TEMPLO
7.	SAY	DECIR	DECIMA
8.	ALL	TODOS	TOROS
9.	QUITE	BASTANTE	BALUARTE
10.	THEN	ENTONCES	ENTERO

List 3

1.	(HE) IS	ES	ESE
2.	NOT	NO	NI
3.	WE	NOSOTROS	NUESTROS
4.	AFTER	DESPUÉS	DE DESDE
5.	THEM	LOS	TOS
6.	(WE) MADE	HICIMOS	HAZAÑAS
7.	WERE	ÉRAMOS	ARAMOS
8.	TEACHER	MAESTROS	MADRASTRAS
9.	ONE	UNO	UNE
10.	THAN	QUE	QUEJA

List 4

1.	OF	DE	DI
2.	(THEY) HAVE	TIENEN	TIÑEN
3.	BUT	PERO	PARO
4.	THINK	PENSAR	PINCHAR
5.	PERSON	PERSONA	PALOMA
6.	(THE) THINGS	(LAS) COSAS	(LAS) CASAS
7.	(THEY) CAN	PUEDEN	PIDEN
8.	MY	MI	ME
9.	SOME	ALGUNOS	ALBINOS
10.	ALWAYS	SIEMPRE	SIEMBRE

List 5

1.	AND	Y	YA
2.	IN	EN	ENE
3.	SHE	ELLA	ECHA
4.	HAD	TENÍA	TINTA
5.	(I) WANT	QUIERO	GÜIRO
6.	ME	ME	MUY
7.	GO	IR	OIR
8.	SO	TAN	TON
9.	(A) COURSE	(UN) CURSO	(UN) CORSÉ
10.	TWO	DOS	DAS

List 6

1. I	YO	YA
2. DO	HAGO	HIGO
3. WITH	CON	CONDE
4. VERY	MUY	MI
5. SOMETHING	ALGO	ALGA
6. AS	COMO	CAMA
7. (TO) HIM (TO HER)	LE	LEO
8. (I) CANNOT	NO PUEDO	NO PIDO
9. (I) AM	SOY	SOYA
10. ANY	NINGUNO	MINGONA

List 7

1. YOU	USTED	ESTADO
2. HE	EL	ELE
3. JUST	NADA MÁS	NADAMOS
4. ON	SOBRE	SABRÉ
5. (HE) SAYS	DICE	DOCE
6. WHEN	CUÁNDO	CUÁNTO
7. GOOD	BUENO	DUEÑO
8. EXAMPLE	EJEMPLO	EJIDO
9. COULD (WOULD BE ABLE)	PUDIERA	PETATERO
10. (HAS) BEEN	HA SIDO	HA SUDADO

List 8

1. IT	LO	LOA
2. ARE	ESTÁN	ESTAÑO
3. IF	SI	SE
4. KNOW (COMMAND)	SEPA	SAPO
5. OUTSIDE	FUERA	FUERZA
6. THIS	ESTO	ESTOY
7. BY	POR	PAR
8. (HE) DID	HIZO	HAZ
9. WAY	MODO	MIDO
10. GREET	SALUDE	SALUD

Sample Items for Picture Vocabulary Lists

1. SACO
2. PUENTE
3. NUBE
4. BARCO

List 9 (Picture Vocabulary)

1. PERRO
2. TAZA
3. LIBRO
4. MANO
5. VASO
6. CASA
7. COCHE
8. MESA
9. CAMA
10. CARTA

List 10 (Picture Vocabulary)

1. PEZ
2. CAJA
3. SILLA
4. PUERTA
5. ÁRBOL
6. IGLESIA
7. TRAJE
8. ZAPATO
9. CUADRO
10. VESTIDO

APPENDIX B

SENTENCES

Sample Sentences

1. Dimos entradas.
2. Aprenden a trabajar
3. Decimos Que La Beso

List I

1. La gente quiere eso.
2. Eso fue para otra gente.
3. ¿Para qué fue eso?
4. La gente quiere otra gente.

List 2

1. ¿Quién vino?
2. Entonces todos actúan.
3. Todos actúan.
4. Ellos dicen todo.

List 3

1. Nosotros los hicimos.
2. Nosotros no éramos.
3. Nosotros hicimos.
4. Nosotros éramos maestros.

List 4

1. ¿Pueden algunos pensar?
2. Algunos siempre tienen cosas.
3. ¿Pueden pensar las cosas?
4. Algunos siempre pueden pensar.

List 5

1. Ella tenía dos.
2. Quiero (un) curso.
3. Ella me tenía.
4. Quiero dos.

List 6

1. Yo soy algo.
2. Yo no puedo.
3. Yo hago algo.
4. Yo hago algo como puedo.

List 7

1. ¿Pudiera usted?
2. Él ha sido bueno.
3. ¿Pudiera él?
4. ¿Cuándo ha sido bueno él?

List 8

1. Sépalo
2. Hizo esto.
3. Sepa esto.
4. Lo hizo fuera.

APPENDIX C

VISUALLY PRESENTED STORY

Nada más salude a (-) Brigitte Bardot," decimos nosotros que éramos los dos maestros. "¿No tienen ustedes ninguna cortesía? Es bueno pensar siempre."

"Pero yo no quiero y no puedo," me dice uno con mal humor.

"Yo pudiera dar un ejemplo muy bueno," dice una persona, y él lo hizo de este modo, la beso.

"¡Fuera! " dice ella, que no tenia muy buen humor. "No quiero ninguna de las cosas que usted hizo. Usted no ha sido tan bueno como los maestros, sépalo. Después de esto, no quiero ir a América. Algunos pueden pensar que yo no soy buena persona."

Nosotros hicimos algo bueno. Le dimos does entradas de Disneyland.

AURALLY PRESENTED STORY

"Yo soy maestro y quiero ir a México," dice Carlos, "y no puedo pensar en mi curso en San José. Una persona pudiera ir por automóvil, si tenía uno."

"Algunos los tienen, paro nostros no y usted no," dice ella. "Los que no tienen automóvil no pueden ir en ningún modo muy bueno."

"Es como usted dice, pero, sepa usted, cuando yo quiero algo, nada más hago dos cosas: pensar y trabajar," dice él.

"Esto es un ejemplo tan bueno. Siempre los que están fuera de los Estados Unidos aprenden cosas.

APPENDIX D

INSTRUCTIONS

Experiments I, II and III

INSTRUCTIONS FOR EACH SUBJECT.[11]

The research project in which you are about to participate is supported by funds from a federal agency of the government called the Department of Health, Education, and Welfare in Washington D.C.

As you probably know from your newspaper reading, we Americans seem to be seriously handicapped in our relationships with other nations due, in part, to our lack of fluency in foreign languages. The long-range objective of experiments like this one is to invent new and more efficient techniques for teaching people how to read and speak a foreign language fluently. Therefore, you can probably sense how important we consider your contribution as a subject.

Please cooperate with the experimenter by carefully following his instructions and attempting to learn the foreign words as quickly as possible. May we make one other request of you? Please do not discuss what happened during the experiment with anyone until the semester is over.

Experiment I

INSTRUCTIONS FOR THE EXPERIMENTER[12]

MEETING I

WELCOME S. GIVE HIM A COPY OF THE SUBJECT-INSTRUCTIONS FOR HIM TO READ. AFTER HE HAS READ THE INSTRUCTIONS, YOU SAY:

First of all, we'd like you to learn some sample words in order that you will be familiar with the procedure in the experiment. Please feel free to ask questions if the procedure is not clear.

NOTE: The instructions presented here were for visual subjects. Instructions for aural subjects were identical except from List 3 on, substitute "listen" for "watch," and substitute "pronounce the Spanish word you select" for "write or print the Spanish word you select."

[11] **Each subject silently read this material.**

[12] **The experimenter orally read these instructions to the S.**

SAMPLE LIST 1 (VISUAL)

In sample word 1 your task is to learn which of these two Spanish words (POINTING TO THEM) means "those who." The first time I show you a card, you will probably not know which Spanish word goes with the English word. If you do not know, make the best guess you can and I will tell you whether you are right or wrong.

When you get an item correct twice in a row, that item will not be presented to you again. The learning of a list is complete when you respond correctly twice in succession to each item in the list. Do you have any question? (PAUSE)

This is important, I will expose the card to you for 3 seconds. When I drop the card like this (DEMONSTRATE), immediately print or write in large letters the Spanish word you selected. (DEMONSTRATE)

It is important that you print or write your response immediately after I drop the card, but not before the card.

Let's go through these sample words and you will see how the procedure works.

- - - - - - - - - - - - - -

SAMPLE SENTENCE 1

Now for a few seconds I will expose a card to you on which is written a sentence in Spanish based on the 4 words you have just learned. When I drop the card, immediately write the English meaning of the sentence on the slip of paper in front of you. Do not begin writing until I drop the card. Ready?

ANSWER ANY QUESTIONS S MAY HAVE CONCERNING THE PROCEDURE.

LIST 1 (VISUAL PREDICTOR)

This time I will present a list of 10 words to you. The procedure is exactly the same as we followed before. Are you ready?

LIST 1 SENTENCES

Just as we did with the sample list I will expose a card to you for a few seconds. You will see a sentence in Spanish based on the 10 words you have just learned. When I drop the card,

immediately write or print the English meaning of the sentence on the slip of paper in front of you. Do not begin writing until I drop the card. Ready?

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

SAMPLE LIST 1 (AURAL)

Please place your pencil on the table. Now I will present the same 4 words you have previously learned in the sample list at the beginning, except that this time you will hear the words. For example . . . (PLAY SAMPLE WORD I).

Instead of writing, I ask you to pronounce the Spanish word you think corresponds to "those who." Pronounce the word you select immediately after you hear the final Spanish word. Do not respond until you have heard both Spanish words. (REPLAY CARD I AND DEMONSTRATE THE ORAL RESPONSE.) Try to pronounce the word you select as accurately as you can.

Just as before, when you get an item correct twoice in a row, it will not be presented again. The learning of a list is complete when you respond correctly twice in a row to each item. Any questions?

SAMPLE SENTENCE I (AURAL)

Please pick up your pencil. Now you will hear a sentence in Spanish based on 4 words you have just learned. Write or print the English meaning of the sentence immediately after hearing the entire sentence. Ready?

ANSWER ANY QUESTIONS S MAY HAVE CONCERNING THE PROCEDURE.

LIST 2 (AURAL PREDICTOR)

This time I will present a list of 10 words to you. The procedure is exactly the same as we followed before, except that the words in this list are new to you. You will not be relearning words you learned visually. The words in this list are completely new to you. Any questions? Ready?

LIST 2 SENTENCES

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

GIVE A 5 MINUTE BREAK

LIST 3 (VISUAL TRAINING)

Now for a new list of 10 words. Watch carefully. Ready?

LIST 3 (VISUAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 3 (AURAL TRANSFER)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

LIST 3 (AURAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

GIVE A 5 MINUTE BREAK

LIST 4 (VISUAL TRAINING)

Now for a new list of 10 words. Watch carefully. Ready?

LIST 4 (VISUAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 4 (AURAL TRANSFER)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

LIST 4 (AURAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

FINAL INSTRUCTIONS TO S

I'd like to remind you not to discuss any details concerning the experiment until the semester is over. Thank you.

REMIND THE SUBJECT OF THE DAY AND TIME FOR HIS NEXT APPOINTMENT.

MEETING 2

SAMPLE LIST 2 (VISUAL)

WELCOME S. GIVE HIM THE INSTRUCTIONS. BE SURE THE WORD BOOKLET IS OPEN TO THE PROPER PAGE.

As a warm up, I'm going to ak you to learn a list of 4 sample words. Try to write or print the Spanish word you select as accurately as possible. Watch carefully. Ready?

SAMPLE SENTENCE 2 (VISUAL)

Now for a sentence in Spanish based on the 4 words you learned. Watch carefully. Ready?

LIST 5 (VISUAL TRAINING)

Now for a new list of 10 words. Watch carefully. Ready?

LIST 5 (VISUAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

SAMPLE LIST 2 (AURAL)

Now I will ask you to relearn the sample list of 4 words by hearing them. Try to pronounce the Spanish word you select as accurately as possible. Listen carefully. Ready?

SAMPLE SENTENCE 2 (AURAL)

Now for a sentence in Spanish based on the 4 words you have learned. Listen carefully. Ready?

LIST 5 (AURAL TRAINING)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

LIST 5 (AURAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

GIVE A 5 MINUTE BREAK

LIST 6 (VISUAL TRAINING)

Now for a new list of 10 words. Watch carefully. Ready?

LIST 6 (VISUAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 6 (AURAL TRANSFER)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

LIST 6 (AURAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

GIVE A 5 MINUTE BREAK

LIST 7 (VISUAL TRAINING)

Now for a new list of 10 words. Watch carefully. Ready?

LIST 7 (VISUAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 7 (AURAL TRANSFER)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

LIST 7 (AURAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

FINAL INSTRUCTIONS TO S

I'd like to remind you not to discuss any details concerning the experiment until the semester is over. Thank you.

REMIND THE SUBJECT OF THE DAY AND TIME FOR HIS NEXT APPOINTMENT

MEETING 3

SAMPLE LIST 3 (VISUAL)

WELCOME S. GIVE HIM THE INSTRUCTIONS.

As a warm up, I'm going to ask you to learn a list of 4 sample words. Try to write or print the Spanish word you select as accurately as possible. Watch carefully. Ready?

SAMPLE SENTENCE 3 (VISUAL)

Now for a sentence in Spanish based on the 4 words you learned. Watch carefully. Ready?

LIST 8 (VISUAL-SPECIAL SET UP)

Now for a new list of 10 words. Watch the square hole in the screen. The words will move across your view. Do not write until you have seen the English word and both Spanish words. Watch carefully. Ready?

LIST 8 (VISUAL SENTENCES)

Now the sentences will move across your view.

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

SAMPLE LIST 3 (AURAL)

Now I will ask you to relearn the sample list of 4 words by hearing them. Try to pronounce the Spanish word you select as accurately as possible. Listen carefully. Ready?

SAMPLE SENTENCE 3 (AURAL)

Now for a sentence in Spanish based on the 4 words you have learned. Listen carefully. Ready?

LIST 8 (AURAL TRANSFER)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

LIST 8 (AURAL SENTENCES)

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

STORY A (VISUAL)

Now I will give you a paper on which is printed a brief story in Spanish. The story is composed of Spanish words you have learned. Try to read the story through from beginning to end, then write a translation of the story.

You will be permitted to reread any part of the story as many times as you please, but the time limit is 25 minutes.

Please tell me if you finish ahead of time.

STORY B (AURAL)

Now you will hear a brief story in Spanish. The story is composed of Spanish words you have learned. Try to follow the story through from beginning to end, then write a translation of the story.

You will be permitted to hear any part of the story as many times as you please but the time limit is 25 minutes. Do you have any questions?

Please tell me if you finish ahead of time.

GIVE A 5 MINUTE BREAK

RECALL & RECOGNITION MEASURE

LISTS 1, 3, 5, 7, (VISUAL)

Now I will give you an English word and you first of all, try to pronounce the Spanish equivalent and then write the Spanish equivalent in your booklet. Any questions?

You will have 20 seconds to make your responses.

On the card I will show you, point with the erasure end of your pencil to the Spanish word you think is correct.

LISTS 2, 4, 6, 8 (AURAL)

THE PATTERN IS THE SAME EXCEPT THAT YOU ASK S TO PRONOUNCE INSTEAD OF WRITE HIS CHOICE WHEN YOU PLAY THE CARDS FOR THE RECOGNITION MEASURE.

FINAL INSTRUCTIONS TO S

Please do not discuss any details of the experiment until the semester is over. Thank you.

Experiment II

INSTRUCTIONS FOR THE EXPERIMENTER

As a small incentive, we will pay you for 2 1/2 hours of your time even though you may complete the task sooner, let us say in an hour or 1 1/2 hours. The idea is to encourage your best effort in learning the material as quickly as possible.

First, I will ask you to learn a sample list of Spanish vocabulary items so that you will see how the procedure works. Your task is to watch carefully and learn which Spanish word represents which picture. For example, this picture (POINT) means this (POINT). Let's go through the list once. (GO THROUGH THE SAMPLE LIST ONCE.)

From now on, when you see a picture, immediately write or print in large letters, as accurately as possible, the correct Spanish word associated with the picture. For example, when you see this, you print this (DEMONSTRATE).

You will see the picture for 1 second, then you will have 5 seconds to print your response, then you will see the correct response for 1 second. Do you have any questions?

When you get an item correct twice in a row, that item will not be presented to you again. The learning of a list is complete when you respond correctly twice in a row to each item. Ready? Watch carefully.

PICTURE-SIGN: LIST 9 (VISUAL TRAINING)

This time I will present a list of 10 picture items to you. The procedure is exactly the same as we followed before. Are you ready?

PICTURE-SIGN: SAMPLE LIST (AURAL)

Please place your pencil on the table. Now I will present the same 4 picture items you have previously learned in the sample list at the beginning except that this time you will hear the words. For example... (EXPOSE SAMPLE PICTURE 1, THEN PLAY THE WORD.)

The procedure is exactly the same as before, except that after the first trial, when you see a picture, your task is immediately to pronounce the correct Spanish word as accurately as possible.

Just as before, when you get an item correct twice in a row, that item will not be presented to you again. The learning of a list is complete when you respond correctly twice in a row to each item. Any questions? Ready? Listen carefully.

PICTURE-SIGN: LIST 9 (AURAL TRANSER)

You have learned 10 Spanish vocabulary items by seeing them. Now you will relearn the same 10 items by hearing them. Try to pronounce the Spanish words as accurately as possible. Listen carefully. Ready?

PICTURE-SIGN: LIST 10 (AURAL TRAINING)

Now I would like you to learn a new list of 10 vocabulary items. The procedure is exactly the same as the list I just presented to you. Listen carefully.

PICTURE-SIGN: LIST 10 (VISUAL TRANSFER)

You have just learned 10 Spanish vocabulary items by hearing them. Now you will relearn the same 10 words by seeing them. Please remember to write or print your response in large letters immediately after you see the picture. Try to reproduce the Spanish words as accurately as possible. Ready?

GIVE A 5 MINUTE BREAK

SIGN-SIGN: SAMPLE LIST

The procedure here is similar to the previous lists except that you will see an English word instead of a picture. For example, you will see this (POINT) followed by this (POINT).

After the first trial, when you see an English word, your task is immediately to write or print the correct Spanish word as accurately as possible.

Let's go through these sample words and you will see how the procedure works.

LIST 1 (VISUAL PREDICTOR)

This time I will present a new list of 10 words to you. The procedure is exactly the same as the sample list you just completed. Are you ready?

SAMPLE LIST

Please put you pencil down. Now I will present a new list of 4 words to you. The procedure is the same except that you will hear the words.

Instead of writing, I ask you to pronounce the Spanish word which corresponds to the English word. For example, the first sample item is... (DEMONSTRATE)

Try to pronounce the Spanish words as accurately as possible. Ready?

LIST 2 (AURAL PREDICTOR)

This time I will present a new list of 10 words to you. The procedure is exactly the same as the sample list you just completed.

FAMILIARIZATION LISTS

Now you will see an English word together with two Spanish words. Your task is to point to the Spanish words which represent the English. If you do not know, make the best guess you can. Ready?

Experiment III

INSTRUCTIONS FOR THE EXPERIMENTER.

MEETING I

SAMPLE LIST 2

Do you remember the items we asked you to guess at a month or so ago in the very first meeting? The items looked like this (DEMONSTRATE). Let me ask you this: What proportion of those items did you guess at?

1/4 1/2 3/4 almost all of them

Did you use any system or scheme in guessing? If so, what was it?

As a small incentive, we will pay you for 2 1/2 hours this meeting and 2 1/2 hours for the next meeting making a total of 5 hours even though you may complete the task sooner, let us say in 3 or 4 hours. The idea is again to encourage your best effort in learning the material as quickly as possible. However, we cannot pay you anything unless you show up as scheduled for both meetings. The reason for this is that if you cannot be here as scheduled next time, we must discard the data we collect from you today and substitute a new subject in your place.

First I would like you to learn a sample list of Spanish vocabulary items to refresh you on the procedure and as a warm up to the regular items. Your task is to watch carefully and learn which Spanish word represents which English word. For example, you will see this (POINT) followed by this (POINT).

After the first trial, when you see an English word, your task is immediately to write or print the correct Spanish word as accurately as possible.

When you get an item correct twice in a row, that item will not be presented to you again. The learning of a list is complete when you respond correctly twice in a row to each item.

However, after learning each list, I will present two sentences for you to translate. The sentences will be based on words you have just learned. Any questions? Are you ready? Watch carefully.

SAMPLE SENTENCE

Now I will expose a card to you on which is printed a sentence in Spanish based on the 4 words you have just learned. When I drop the card, immediately write or print the English meaning of the sentence on the notebook paper in front of you. Do not begin until I drop the card. Ready?

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 4 (VISUAL TRAINING)

This time I will present a list of 10 items to you. The procedure is exactly the same as we followed before. Are you ready?

- - - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

SAMPLE LIST 2 (AURAL TRANSFER)

Please place your pencil on the table. Now I will present the same 4 picture items you have previously learned in the sample list at the beginning except that this time you will hear the words. For example... (EXPOSE SAMPLE PICTURE 1, THEN PLAY THE WORD.)

The procedure is exactly the same as before except that when you hear an English word, your task is immediately to pronounce the correct Spanish word as accurately as possible.

Just as before, when you get an item correct twice in a row, that item will not be presented to you again. The learning of a list is complete when you respond correctly twice in a row to each item. Any questions? Ready? Listen carefully.

- - - - - - - - - -

LIST 4 (AURAL TRANSFER)

You have learned 10 Spanish vocabulary items by seeing them. Now you will relearn the same 10 items by hearing them. Try to pronounce the Spanish words as accurately as possible. Listen carefully. Ready?

- - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 5 (VISUAL TRAINING)

Now I would like you to learn a new list of 10 vocabulary items. The procedure is exactly the same as the list I just presented to you. Watch carefully.

- - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 5 (AURAL TRANSFER)

You have learned 10 Spanish vocabulary items by seeing them. Now you will relearn the same 10 items by hearing them. Try to pronounce the Spanish words as accurately as possible. Listen carefully. Ready?

- - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

GIVE A 5 MINUTE BREAK

LIST 6 (VISUAL TRAINING)

Now I would like you to learn a new list of 10 vocabulary items. The procedure is exactly the same as the list I just presented to you. Watch carefully.

- - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 6 (AURAL TRANSFER)

You have learned 10 Spanish vocabulary items by seeing them. Now you will relearn the same 10 items by hearing them. Try to pronounce the Spanish words as accurately as possible. Listen carefully. Ready?

- - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

MEETING 2

SAMPLE LIST 3 (VISUAL TRAINING)

This sample list is a warm up. Are you ready?

- - - - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 7 (VISUAL TRAINING)

Now I would like you to learn a new list of 10 vocabulary items. The procedure is exactly the same as the list I just presented to you. Watch carefully.

- - - - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

SAMPLE LIST 3 (AURAL TRANSFER)

Now I will present the same 4 words you have learned except this time you will hear them. Instead of writing, I ask you to pronounce the Spanish word which corresponds to the English word. Try to pronounce the Spanish word as accurately as possible. Ready?

- - - - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 7 (AURAL TRANSFER)

You have learned 10 Spanish vocabulary items by seeing them. Now you will relearn the same 10 items by hearing them. Try to pronounce the Spanish words as accurately as possible. Listen carefully. Ready?

- - - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 8 (VISUAL-SPECIAL SET UP)

Now for a new list of 10 words. Watch the square hole in the screen. The words will move across your view. After the first trial, when you see an English word, immediately write or print the corresponding Spanish word, then be sure to look up at the square to compare your response with the correct word which will cross your view. Any questions? Watch carefully. Ready?

- - - - - - - - - - - - - -

Now the sentences will move across your view.

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

LIST 8 (AURAL TRANSFER)

Now I will ask you to relearn the list of 10 words by hearing them. Listen carefully. Ready?

- - - - - - - - - - - - - -

Ready for Spanish sentence 1?

Ready for Spanish sentence 2?

RECALL MEASURE

This is a measure of retention. If I show you a picture, try to pronounce the correct Spanish word, then write it in your notebook. If you see or hear a Spanish word, try to give me the English meaning. Ready?